THE UNIVERSITY OF ALBERTA

LABORATORY INVESTIGATIONS OF SOME VARIABLES INFLUENCING STRENGTH OF A SILTY CLAY WITH A LIME-POZZOLAN ADDITIVE

A THESIS

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JOHN HVOZDANSKI

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ABSTRACT

An attempt was made to place on a scientific basis, the increase in strength caused by addition of lime and pozzolan to a silty clay. Though used in biblical times, the design of stabilized soil using these materials has progressed little past the stage of an art. Although a silty clay soil found in a considerable part of Alberta was used, the approach was widened to generally include sands, silts and clays particularly in the literature research. Upon preliminary indications there appeared a possible approach to strength predications based upon Feret's Granulometric Theory but after further work the varying gradation caused by varying lime content precluded any helpful relationships from being formulated. A second approach in which the total strength was separated into "modified" strength and "cemented" strength proved somewhat more encouraging. The test program itself consisted of preparing six identical cylindrical test specimens at each of twenty-two additive contents, repeated twice more for a total of three different compactive efforts. All of the specimens were cured in air-tight containers for

twenty-eight days, soaked for twenty-four hours and then tested in an unconfined compression machine loaded at one-tenth of an inch per minute. A secondary pilot test program was conducted to evaluate a constructed freeze-thaw test unit. Generally in the primary investigation the unproductive test regions of the, "Strength v.s. Additive Content" graph at twenty-eight days moist curing were indicated, an estimate of possible strength increase was provided, and samply preparation techniques were scrutinized. In conclusion it appeared that this dissertation would act more as a spring board for further research along the indicated avenues, that is a progress report, rather than providing any new theory on strength increase prediction.

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INTRODUCTION

The increasing cost of supplying granular material acceptable by our present day specifications, indicates that the upgrading of materials unacceptable or barely tolerable by these specifications, is one answer to decreasing these costs. Since it is the soil void-filler that renders a large amount of granular material unacceptable for constructing pavements for roads, parking areas and runways, the beneficial modification of either soil void-filler or the basement soil upon which these structures rest with regard to strength will allow a decrease of pavement thickness and therefore, the amount of granular material required. The approach in this investigation is to modify either the soil void-filler or basement soil in such a way as to increase the strength of the whole. Therefore even though only a plastic soil is investigated, the problem approached is use of borderline granular materials by modifying the "fines".

Results of many investigations both in the laboratory and in the field prove that a beneficial change

occurs when lime or lime-pozzolan is added to fine grained soils, whether the fine grained soil is the whole or only the "strength robbing" portion of a granular material. This investigation attempted to relate unconfined compressive strength to percent admixture, ratio of lime-to-pozzolan, and compactive effort or density, with a unique law; to circumvent rule-of-thumb mixture designs or large scale investigations similar to this one, that are now employed. A silty cohesive soil was used with varying amounts of lime, pozzolan, and three compactive efforts to encompass a broad area of mixtures and thereby also determine the more productive combinations for future testing. In the literature search the subject was expanded to include materials ranging from highly plastic soils to sandy soils. An evaluation of a modified British Freeze-Thaw apparatus for further large scale investigations was also effected.

I PERSPECTIVE

Stabilization is the act of making firm or stable, and in soil mechanics it denotes the increasing of certain desirable properties in construction materials. Primarily,

this consists of reducing the detrimental effects of excess moisture and using the surface tension and increased cohesion of the lower moisture contents to advantage. Compaction is the most commonly used of the various methods, with admixtures receiving more attention of late. Five divisions of admixtures for stabilization are:

(a) cementing agents

(b) modifiers

(c) water proofers

(d) water retaining agents

(e) water retarding agents

In his text, Yoder (1959) p. 259, expands the preceding into a concise but complete summary of stabilization. There are limitations to each manner of soil stabilization whether it be uneconomical, difficult to perform or of short term durability. So a proper preliminary evaluation is required before using admixture stabilization. These questions should be asked:

(a) Is it necessary?

(b) Is it the most economical?

(c) Which method is most adaptable to the existing conditions?

In some cases altered gradation and/or increased compaction may supply an answer while in other instances controlling moisture conditions by, for example, intelligently designed drainage installation, may prove to be the most economical. Once the use of admixture stabilization is shown to be reasonable, then lime and lime-pozzolan may be considered.

II LIME-SOIL AND LIME-POZZOLAN-SOIL REACTIONS

Lime added to soils can cause three main reactions. Firstly, by altering the surface charge of the colloid fraction the lime causes the soil to form a "flocculated" or agglomerated structure which lessens plasticity <u>but</u> increases the plastic limit. Secondly, hydrated lime, atmospheric moisture and carbon dioxide form a weak cementing agent of calcium carbonate. Thirdly, in the presence of pozzolan, whether occuring naturally in the soil or supplied artificially, the lime forms an interparticle "glue". Whether this latter postulated product is amorphous or crystalline is beyond the scope of this investigation, but is very likely important in deciding re-growth of strength and subsequent durability of the cemented soil.

III VARIABLES AFFECTING REACTIONS

Density, temperature, curing time, type of soil-pozzolan-lime blend, amount of moulding water, percentage of total additive, ratio of lime to pozzolan, relative humidity and chemical impurities present, are major variables affecting the interaction. In this investigation temperature, curing time, type of soil-pozzolan-lime, relative humidity and chemically accelerated reaction were predetermined for the entire investigation, though considerable variation in the relative humidity was present. The amount of moulding water for soil alone, or for soil plus additive was predetermined from the moisture-density relation at the optimum condition. The decided investigation consisted of three compactive efforts, eight various additive contents and four main differing ratios of lime to pozzolan.

IV DEFINITION OF TERMS USED

ADDITIVE - the total amount of lime and pozzolan based upon the total dry weight of soil plus lime and pozzolan. This was used for convenience reasons in this investigation. The other

alternative which was not used unless specifically stated was the additive percent by dry weight of soil only, probably more useful in the field.

CEMENTATION STRENGTH - meant as a measure of any bonding of particles occuring over a period of time and determined as the difference of unconfined compressive strength between a specified curing period and no curing period.

COHESION - the attraction that unites substances of like characteristics and resists a force tending to disrupt the mass. (H.R.B. Special Report No. 25).

FLY-ASH - finely ground residue that results from the combustion of ground or powdered coal and is transported from the boiler by flue gases (A.S.T.M.).

ILLITE (hydrous mica) - one of the three major groups of silicate clay minerals. The crystals are built up of units of three alternating sheets, two silica to one alumina or a 2 to 1 lattice. The units are bonded together by potassium

atoms, which exert a stabilizing effect on the crystal lattice. The illites may expand slightly, but rarely enough to be of significance (H.R.B. Special Report No. 25).

KAOLINITE - one of the three major groups of silicate clay minerals. The crystals are plate like any roughly hexagonal in shape. The crystals are built up of flat crystal units, each layer being composed of alternate layers of alumina and silicate sheets. There is one alumina sheet for each silica sheet or a 1 to 1 lattice. The kaolinite crystals are the most stable of the layer-silicate clay materials, the bonding between units is firm, and they offer less surface area than other clay minerals. The kaolinites exhibit few Colloidal properties (H.R.B. Special Report No. 25).

LIME - a substance produced by heating limestone (and/or dolomite) to 825 degrees C or more, as a result of which carbonic acid and moisture are driven off. Also a general

term which includes the various chemical and physical forms of quicklime, hydrated lime and hydraulic lime used for any purpose (for further see A.S.T.M. C. 51-47).

MONTMORILLONITE - one of the three major groups of silicate clay minerals. The crystals are built of units of three alternating sheets, two silica to one alumina, magnesium or iron sheet or a 2 to 1 lattice. The units are bonded together by weak oxygen-to-cation-to-oxygen linkages, which allows the crystal lattice to absorb water on the interval surfaces. This condition gives the montmorillonite high swelling and shrinkage properties. The crystals are much smaller than the crystals of illite and kaolinite. Montmorillonite is noted for its high plasticity and cohesion (Bentonite is a rock formed from volcanic ash that has been weathered to montmorillonite) (H.R.B. Special Report No. 25).

PLASTIC LIMIT - the lowest moisture content at which the bonds between soil particles or "aggregates" can be constantly renewed (after Hilt and Davidson). See page 99 of reference 2 for classical definition of plastic limit.

POZZOLAN - a silicious or alumino-silicious material which in itself possess little or no cementitious value but which in the finely divided form and in the presence of moisture will chemically react with alkali and alkaline earth hydrozides at ordinary temperatures to form or to assist in forming compounds possessing cementitious properties (A.S.T.M.C. 379-56T).

RATIO - the ratio of commercial hydrated lime to Diamond City shale, in this investigation, based on the ratio of the weights i.e. 40 gms. lime to 360 gms. pozzolan equals a 1:9 ratio of lime to pozzolan.

UNCONFINED COMPRESSIVE STRENGTH - this is a relative strength in this investigation and not a true strength, as the sample had a L/D ratio of 1 requiring a reduction to 85% of the tested value. Also unless specified, all these relative values were obtained by immersing the sample in distilled water for twenty-four hours then surface drying and testing in a constant strain loading frame.

V DISCUSSION OF APPROACH

Basically the approach was to separate the two components of strength increase:

(a) increased "cohesion" including any cementation effects;

(b) increased interlocking and interparticle friction.

These two items could be compared to Coulomb's empirical equation and its two-component system; the cohesion component supplied by the cementation effect and the interparticle friction by the modifying action of the lime upon the material. The size of the two effects depends

basically upon the soil. For sands the increased strength due to soil modification can be said to be nil but the cementation effect appears to be at a maximum. Generally the opposite appears true for the clays. By isolating the cementation strength, the important variable of strength growth in soils with lime additives can be investigated. The writer feels that this "strength" is the one to be considered in durability aspects, and in prediction of time-strength relations. In determining the cementation strength, the modified strength is taken as the unconfined compressive strength at no curing time and includes the capillary surface tension strength increases as a necessary evil because this can not be avoided. The cementation strength then is taken as the difference between the total unconfined compressive strength and the modified strength. Regrettably this approach is hampered by approximations of the modified strength as previously outlined.

Originally it was thought that some unique relation existed between cement-filled-voids and some compressive strength. This gave only varying empirical results, causing this line of approach to be abandoned.

Insofar as discussion of whether the strength increases are sufficient for the purposes required; these purposes must be first determined and then the strength as needed should be tested for durability. That is, the requirements for a subgrade strength increase will be much less than a required strength increase for a base course, if the same material is used for both purposes.

VI SUMMARY

The improvement of locally occurring construction materials can be accomplished by the use of lime or lime-pozzolan admixtures to soils, but a basic fundamental law of strength increase is required to lessen trial and error procedures.

History, a brief review of present road pavement design and lime-pozzolan's place in these design philosophies, and a summary of existing knowledge about the subject; bring the dissertation to the fabrication and testing program. Hereafter on the basis of Feret's strength law[1] a fundamental strength relation with the cementing material, is attempted. A pilot attempt of freeze-thaw testing closes this program.

1 Refer to Chapter IV Section VII

CHAPTER II

THE STATUS OF LIME-POZZOLAN ADMIXTURES

A historical review and the use of lime-pozzolan in the present design methods and philosophies provide further perspective upon this subject.

I HISTORY

The use of lime-pozzolan-soil mixtures dates probably from the time of written history. Five thousand years ago the Pyramids of Shensi were constructed of clay and lime. The Great Wall of China, a few Egyptian structures, many Greek and Roman buildings, were constructed using lime or lime-pozzolan cements. The present state of these various structures attests to the permanency of this cementing material. Egyptians, though aware of lime, used gypsum because of its lower heat of calcination. The lack of rain made the gypsum as permanent as lime. Both the Greeks and Romans used a volcanic source of pozzolan, which was ground with the calcined lime to form the cementing agent. The present state of Caligua's wharf, constructed during the Roman

period, proves the underwater curing ability of the lime-pozzolan mixtures. Several investigators feel that the main cause for excellent durability in these cases, was that the overburden pressure created a mortar with high density resulting in intimate particle contact.

From the time of the Roman Empire to the present century, only sporadic usages of lime or lime-pozzolan and soil occurred. During the 1920's and 1930's several states in the United States of America attempted to improve the natural materials with lime but insufficient knowledge of such basics as mixing, compacting, curing, and protection with a wearing surface, caused many failures and a resulting distrust brought about suspension of its use. Since World War II, Texas, has become one of the leading users of lime and lime-pozzolan admixtures. Several other states have had considerable success with lime and lime-pozzolan test strips. Canada, as reported by Robertson (1959)[1], has only several small test strips plus 1.6 miles of a thirty-two foot wide road on the Selkirk Bypass in Manitoba. Two of these test

[1] See Bibliography at end of text.

strips comprise 20,000 square feet in Metropolitan Toronto. Therefore, a rebirth of the possibility of using lime and lime-pozzolan admixtures has started, principally to offset depleted granular supplies.

II INTEGRATION INTO PAVEMENT DESIGN

If a method for predicting strength growth of lime-pozzolan-soil mixtures could be developed, then the design of these mixtures for roads, runways and parking lots could be placed on a semi-rational basis without requirement of either an empirical prediction of strength or a major test program to determine it. This approach would include such items as sub-base of primary roads, base course of secondary roads, shoulders, base course of runways, taxiways, and parking lots and possibly surfaces of tertiary roads, and small runways.

The addition of lime or lime-pozzolan to soils and "dirty" gravels increases both their shear strength and tensile strength. If the adhesion of a clay is greater than the cohesion in a gravel, then it may coat the granular material with a lubricating film (Hogentogler and Willis, 1936), and thereby decrease the shear strength. Lime

increases the cohesion of the clay, while lime-pozzolan additives provide a weak bonding of the clay matrix and in the case of a fine grained soil, also a small bending moment resistance. Three general philosophies of pavement design exist. The rigid pavement utilizes the flexural strength of the structure and is largely independent of the underlying soil. The flexible pavement uses the shear strength of both the pavement and the underlying soil and is largely dependent on the underlying soil for design. While still in the formative stages, a composite, or semi-flexible or semi-rigid pavement, depending on <u>both</u> the shear strength of the underlying soil and the flexural strength, is possible.

Once the permanency of the tensile strength of lime-pozzolan additives is determined under field conditions, then the flexural component can be used in design. However, at the present time only the <u>short term</u> strength, which is relatively permanent and due mainly to increased friction, should be used. This indicates that the two general existing methods of flexible pavement design utilizing, either the improved classification of Group Index and Federal Aviation Agency approaches, or the improved strength in the empirical and semi-rational approaches can

be used for design. The latter requires an optimum strength for each type of soil predicted from a few simple tests of lime-pozzolan-soil mixtures. An example of this is the California Bearing Ratio test.

III THE PRESENT PROBLEMS

The very empirical type of data available and the lack of field to laboratory correlation of strength and durability provide the main stumbling blocks to a knowledgeable approach to the problem of optimum benefit from lime. Slow development of cohesive bonds result in relatively low freeze-thaw and wet-dry resistance at early ages. The low freeze-thaw resistance limits both the length of construction year and geographical use. It is considered that the primary problem is the determination of some principle(s) which will quickly provide the optimum strength condition for each unique system of lime and soil or lime, pozzolan and soil. Once this is overcome then the investigation of such problems as durability and increased rate of cure may be performed, with a minimum number of test samples, so eliminating much unproductive work.

CHAPTER III

THE CONSTITUENTS AND THE INFLUENCING VARIABLES

The following chapter will endeavor to discuss each component of the lime-pozzolan-soil system separately and indicate the variations in each one that influence the end product. Though a basic constituent, water is ignored because its effect on the system is controlled by the type and amount of other constituents added, making it a passive or catalytic agent.

I LIME

Lime is obtained by heating limestone or dolomite sufficently to remove the carbon dioxide leaving either calcium oxide or magnesium and calcium oxide. Hydration of either or both of these two oxides and regrinding, forms the hydrated lime. Six forms of lime can be prepared if the raw materials of limestone and dolomite are available. These six forms are as follows:

(1) calcitic oxide CaO (quicklime),

(2) dolomitic oxide $CaO + MgO$,

(3) calcitic hydroxide $Ca(OH)_2$,

(4) dolomitic hydroxide $MgCa(OH)_4$,

(5) calcium monohydrate $CaO + Mg(OH)_2$,

(6) dolomitic monohydrate $MgO + Ca(OH)_2$.

By themselves, calcitic quicklime and dolomitic monohydrate in lime-pozzolan-soil systems provide the highest compressive strengths while in the presence of strength accelerators, hydrated calcitic lime is the most advantageous for strength growth. Hydrated lime contains less calcium on an equal weight basis than quick lime and so costs more for transportation per unit of reactivity, while the latter is more caustic and therefore more dangerous to human health. Before deciding upon the type of lime to be employed, several laboratory, economic and field factors must be considered. The source and type available usually are major factors. Until the qualities desired of a lime can be predicted in the soil stabilization field, the existing lime product quality as governed by its use in other applications will have to be used. The chemical and physical analysis (A.S.T.M. C 25-58 and C 110-58) appear to be satisfactory control for specifications at present. If lime is handled in bulk, then care should be taken to prevent carbonation.

In the presence of moisture and carbon dioxide, coating of particles by calcium carbonate may occur. This coating will slow the chemical interaction between the various constituents. A lime which has been over heated during calcination will also be less reactive. Therefore control of lime qualities is necessary if inert or semi-inert materials are to be avoided.

II POZZOLAN

Pozzolan is a thermally altered material supplying largely an amorphous mass of alumina and silicate, which in the presence of calcium hydroxide forms a cementing agent (s) of the calcium-alumino-silicate type. At the present stage of investigation it is unknown if these cementing agents are amorphous, crystalline or both. Pozzolans may occur, naturally, as a byproduct or be manufactured. The following list is taken from page 166 of, Blanks and Kennedy, (1955):

naturally occurring pozzolans include:

1. Clays and shales.
   (a) Montmorillonite types.
   (b) Kaolinite types.
   (c) Illite types.

2. Opaline materials.
   (a) Opaline shales.
   (b) Diatomaceous earths.
   (c) Cherts.

3. Volcanic tuffs and pumicites.
   (a) Rhyolitic types.
   (b) Andesitic types.
   (c) Phenolitic types.
   (d) Basaltic types.

---. Artificial pozzolans come from industrial byproducts or wastes and include flyash (flue dust), such as is produced in powdered coal-burning powerplants, silica fumes, powdered brick, burnt oil shale, and some slags.

One of the most widely available sources of pozzolanic material is flyash. The reactivity of the flyash appears to depend on the type of precipitator, which in turn largely determines the amount of carbon impurities. Organic contents of over ten per cent slow the reactions substantially. Some natural clays appear to supply pozzolan from their structure and require little if any, additional pozzolans to form cementing agents. How a clay (and probably shale) will be affected by the lime appears to depend largely on the structure of the clay itself. Apparently calcination of the clay or shale at some specific temperature between 800 and 2000 degrees Fahrenheit and grinding to a silt size will improve the cementing properties.

The cementation reaction will be slowed by coatings such as carbon and calcium carbonate on the pozzolan or by pore water conditions which prevent a plentiful supply of disaccociated calcium hydroxide. Heating of pozzolans may increase, not affect, decrease or destroy its reactivity depending upon the calcination temperature, which evidently determines the amount of crystalline or amorphous materials. This usually requires a trial and error approach to determine the most beneficial temperature.

Several investigators have attempted to correlate the reactivity of pozzolans with some one factor but have had limited success and produce only generalities. Compressive tests utilizing a lime, pozzolan and inert soil appear to be the most satisfactory way of determining reactivity. The most generally used method is a 1:2:9 mixture of lime, pozzolan, and Ottawa sand by weight to form a sample two inches in diameter by four inches in height. Over one thousand p.s.i. compressive strength at seven days cured at 70 degrees Fahrenheit, indicates an active pozzolan. Below this value are intermediate and non reactive ones. Fairly complete data can be obtained for predicting reactivity of a pozzolan from a combination of,

chemical analysis, petrographic analysis, x-ray diffraction, and differential thermal analysis. The crystalline substances are identified by x-ray diffraction, while differential thermal analysis provides data on amorphous substances and endothermic and exothermic reactions. In view of the large number of variables affecting lime-pozzolan-soil interactions, the most promising method of determining the best suitable (most reactive) pozzolan is to use the standard cylinder test. Finally it should be remembered that pozzolans come in many forms and any thermally altered wastes may prove to be a source, as long as the material has a large specific surface area, similar to that of a silt size.

III SOIL

There are three basic divisions of soil utilized in this investigation; sands, silts, and clays. In sands the modifying action as later described does not occur. The strength increase is due to the cementing action of the void filler of lime and pozzolan. At least one group of investigators, Minnick and Miller (1950, Discussion), indicate that the optimum strength for one set curing period does not always occur at maximum density for

granular materials. Whether this condition would change if the curing time was increased, it is not known. Clays are first modified by lime to a less plastic soil by aggregation, then, the interparticle bonding increases the existing cohesion further. Therefore, there must be sufficient lime to both modify the soil and then cement its particles. Silts may be slightly modified, depending upon their cohesive properties. Then these particles are bonded by the mechanical gluing. Sands require a pozzolan with the lime if other than a weak carbonate bonding is to occur. Silts in some cases may be partially a pozzolanic material, so further addition of this material may be detrimental. Clays, particularily the more plastic ones, may provide pozzolan from their internal structure, thus the addition of further pozzolan in some instances smothers the reactions. The structure of the clay determines the usefulness of pozzolan additives. The three basic types of clays are montmorillonites, illites and kaolinites in order of decreasing activity. Two major factors influencing the structure of plastic soils are: a) geologic origin or parent soil and, b) geological climate conditions. For example, in

humid temperate conditions the surface growth and downward percolation of water produce an acidic soil, while in semi-arid temperate conditions surface of evaporation may cause an upward movement of moisture which results usually in alkaline soil. Work by Leadabrand, Norling and Hureless (1957), indicated that the use of the Pedalogical System as used by the United States Department of Agriculture, could accurately predict the amount of Portland cement required in soil cement. This is based on the theory that identical soils would require the same amount of cement regardless of the location, because the climatological and geological factors which determine the chemical composition of the material, also determine the classification. Since chemical composition appears to govern behavior of lime-pozzolan-soil mixtures, then this extrapolation of test results should be applicable to this field of endeavor also. To date, little agreement has been found between additive requirements and the physical constants in lime-pozzolan-soil mixtures, though the latter may be used for predicting mix behavior during construction. So it would appear that chemical composition of the soil or some indicator of this item provides the best approach to

predicting behavior of lime-soil and lime-pozzolan-soil mixtures, but investigation along this direction is beyond the scope of this thesis.

In summary, there are indications that minor differences in chemical and physical properties of one or all constituents can and will cause major differences between identically prepared mixtures of lime-soil or lime-pozzolan-soil.

CHAPTER IV

PRESENT STATE OF KNOWLEDGE

The present state of knowledge of lime-soil and lime-pozzolan-soil mixtures can be said to be at the macroscopic level. It is known that the addition of lime or lime-pozzolan to a soil causes a strength increasing reaction, and that both the quantity of colloid sizes and the plastic index are reduced, the first drastically so. The exact interactions are not known. General hypotheses have been suggested to explain the change but these are from analogous conditions or by inference from test results. Summarization of knowledge of the more important items is attempted in the following pages, but the coverage is enlarged from the silty-clay materials used in this investigation, to include sands, silts, and clays.

I POSTULATED REACTIONS

Clare and Cruchley (1957), cite previous literature generally indicating the following reactions when lime alone is added to soils:

(a) A crystalline cementing of particles because of a supersaturated calcium hydroxide solution in the pore spaces.

(b) Replacement of cations on the clay nucleii by calcium ions which in turn create a "flocculated" structure.

(c) Atmospheric carbon dioxide and moisture reacting with hydrated lime to provide calcium carbonate - a weak cementing agent.

(d) Formation of calcium silicates and/or aluminates by reaction with the clay to form stable "gluing" compounds.

The use of the pozzolan in addition to lime will improve the last enumerated reaction, particularily with silty and sandy materials. Some clays provide the pozzolanic material from within their structure. But whatever the source, it is necessary to form a strong bond, as lime by itself forms the calcium carbonate bond only in the presence of carbon dioxide and will not cure under water. So it may be said for some clays at least, that the lime and lime-pozzolan reactions are similar.

Work by Leonard and Davidson (1959) and others indicate that eventually all of the calcium hydroxide is converted to some other crystalline form by passing through the intermediate form of a gel. Both of these forms cause particle bonding. Research by Izmailova and Segalova (1957, 1958), with growth of crystals from saturated gypsum solutions indicate that while the crystalline structure provides "molecular welding", and is not easily reversible, the strength depends on the type of crystals formed and is sensitive to saturation, temperature, and type of "trigger" nucleii present. Investigations in freeze-thaw, wet-dry cycles, plus those of calcitic quick lime reactions indicate at least a temporary increase in strength which could be due to any one or all of these; temperature, saturation and pressure variations. Auto-healing powers as noticed by Viskochil, Handy and Davidson (1957), after overcompaction swelling, may also be a form of the above. That is, a redeposition of crystals due to environmental changes. The modifying action of lime upon fine grained soils can be explained by ion exchange, (Thomson, 1960). The addition of any one of several bivalent metallic cations will tend to create a "flocculated"

structure, whose strength of bonding depends upon the dominant cation. Gradation alteration due to addition of hydrated lime has been shown to occur in clayey material, (Lund and Ramsey, 1959). Their research on a glacial clay indicate that the upper size limit that was affected was 0.05 m.m. or about the No. 270 sieve size, at a curing time of one hour. If curing was allowed to continue past one hour, further flocculation of the No. 200 sieve to No. 10 sieve sizes occurred. The amount of "flocculation" varied directly as the amount of lime added. So, "flocculation" or aggregation does occur, and apparently depends upon both the amount of lime present and the length of the curing period.

Atmospheric carbon dioxide, moisture and calcium form calcium carbonate, a weak bonding agent which coats the particles and slows if not prevents further pozzolanic reaction. Though the carbonate has a weak cementing affect, it prevents the stronger cementing reactions from occurring and so is undesirable. The lack of strength due to carbonation becomes evident only after several months of curing.

Many of the reactions that occur in Portland cement concrete are also alleged to occur in lime-pozzolan-soil mixtures, so research in the primary technology can in part apply to the latter. One of the more important variables is that both the lime and pozzolan should be in a finely ground form to provide optimum reaction.

Clare and Cruchley (1957), in their experiments discount the carbonate and calcium hydroxide crystal bonding because total enclosure and relatively constant conditions did not favor the reactions. There appear to be possibilities that removal of pore water by chemical reactions may again supersaturate the pore solution of calcium hydroxide and cause crystals to grow.

II RANGE OF ADMIXTURE AMOUNTS

Hilt and Davidson (1960), present data indicating that a minimum of two to three per cent of lime by weight of dry soil must be present before any strength increase occurs. Lesser amounts are used to modify the soil and are not available for increasing atrength. Also, amounts less than two per cent of lime allowed test samples of fine grained soil to disintegrate when submerged. The above

investigators postulated that the minimum amount of lime required before a permanent strength increase will usually occur is called the "lime fixation capacity" and can be determined by the point where the increase in plastic limit become relatively small with equal increments of lime. Harvey (1960), also found that the change in plastic limit was not permanent below a certain lime additive content. As a rule-of-thumb approach the minimum amount of lime required for a permanent strength increase for most soils, can be taken as three per cent by weight. The maximum amount of lime or lime-pozzolan is limited by economics. McDowell (1959), illustrated by a chart (see fig. 1) that the, Optimum Strength versus Lime Added, relation is a time dependent variable and not a constant, therefore, requiring an intelligent choice for field use. For fine grained soils the general consensus appears to indicate a maximum of ten to twelve per cent lime by weight of total dry mixture. For gravelly materials only, Minnick and Miller (1950, Discussion), indicate that the optimum density or when the admixture pastes just fills the voids, determines the amount of additive. This was not true for an A-3 sand.[1]

[1] As outlined in A.A.S.H.O. Designation M145-49

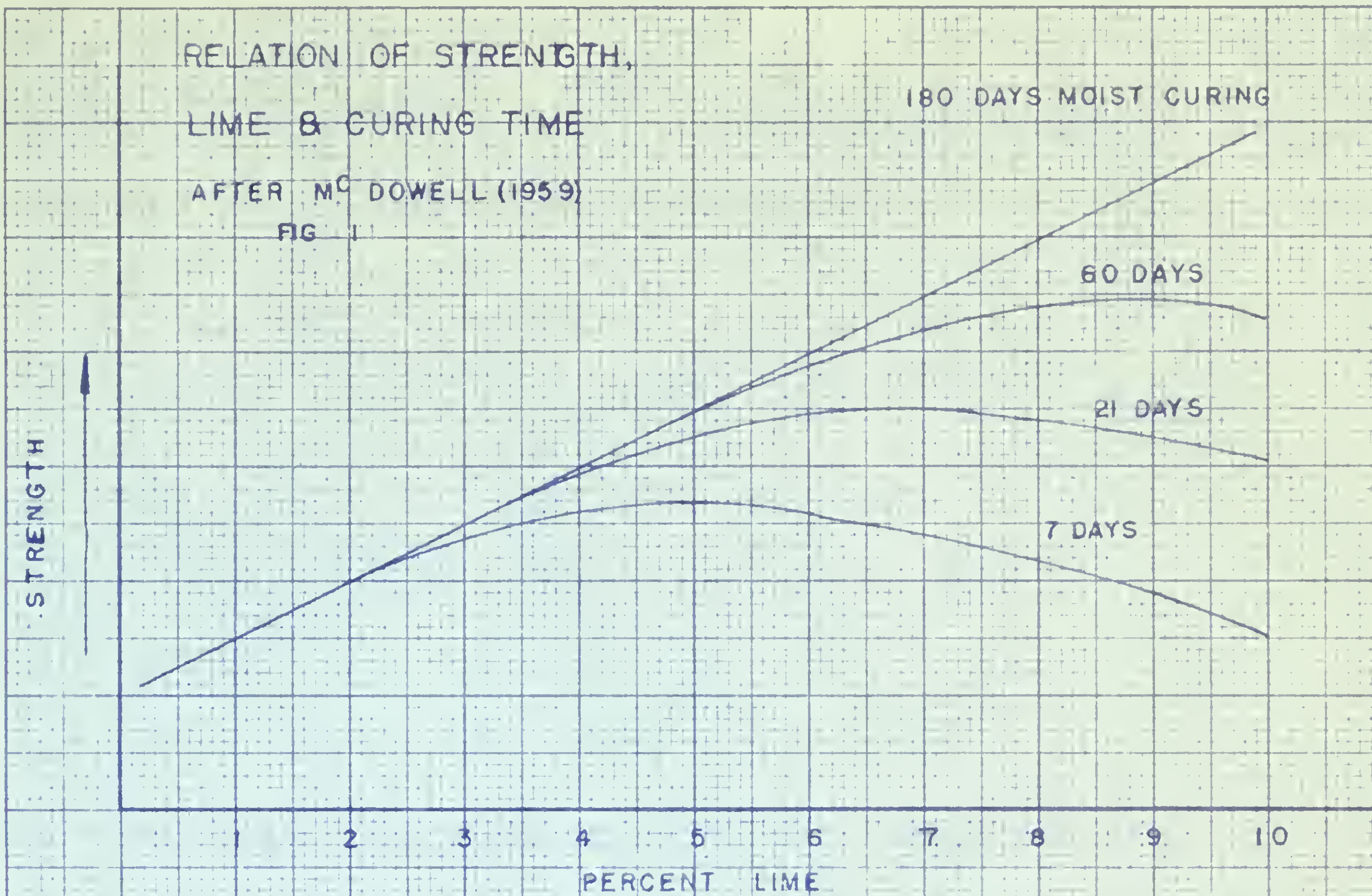

RELATION OF STRENGTH,
LIME & CURING TIME
AFTER M^C DOWELL (1959)
FIG 1
180 DAYS MOIST CURING
60 DAYS
21 DAYS
7 DAYS
STRENGTH
1 2 3 4 5 6 7 8 9 10
PERCENT LIME

FIG 1

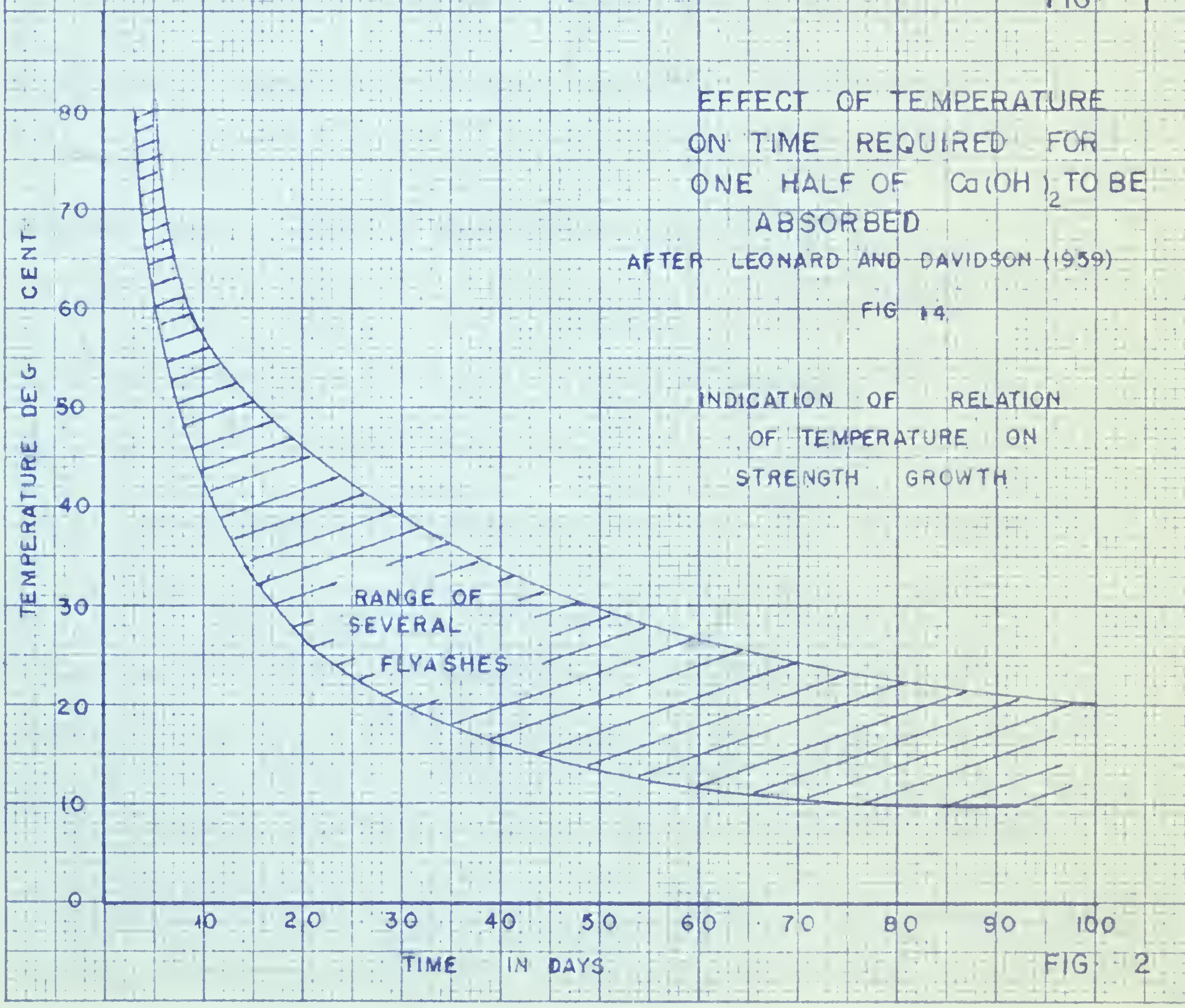

EFFECT OF TEMPERATURE
ON TIME REQUIRED FOR
ONE HALF OF Ca(OH)2 TO BE
ABSORBED
AFTER LEONARD AND DAVIDSON (1959)
FIG 14
INDICATION OF RELATION
OF TEMPERATURE ON
STRENGTH GROWTH
RANGE OF
SEVERAL
FLYASHES
TEMPERATURE DEG CENT
0 10 20 30 40 50 60 70 80
10 20 30 40 50 60 70 80 90 100
TIME IN DAYS

FIG 2

So the range of additives may vary from a minimum of three per cent lime to an economic maximum.

III RATIO OF LIME TO POZZOLAN

Hoover, Handy and Davidson, (1958), using a constant total additive of twenty-five per cent, investigated several ratios of lime to flyash at four compactive efforts, and found that for each, a silt, a sand, and a clay, the optimum ratio varied from 1:9 to 2:8. The one fact appears that the lime content varied from three to twelve and one half per cent and this effect would necessarily cause a variation in strength, unless the total additive rather than the amount of lime is the controlling factor. On the basis of construction in the field, constant compactive effort rather than a constant predetermined density is the most satisfactory method of strength comparison at differing ratios. Lea, (1940), may have solved the problem of optimum ratio when he estimated that under normal field conditions, a pozzolan in one year would react with not more than 20% of its own weight of lime. If the twenty-eight day laboratory strength can be assumed to indicate the state of cohesion in the field after

one season, then a maximum ratio of 1:5 (lime to pozzolan) should provide the maximum strength for each additive content. Investigations indicate that a ratio from 1:9 to 2:8 provides optimum strengths at densities above Standard Proctor with clay, silts and some sands. The ratio 2:8 can be also stated as 1:4, but for the sake of consistency in this investigation it is based upon a ten-unit basis.

IV CURRENT TEST METHODS

Determination of soil strength can be used as an indicator of material classification for pavement design or as a indicator of durability of sample. When used as a material classifier, the strength test determines the absolute value of either tensile (flexural) or shear (compressive) strength, while for durability the relative progressive change in either value of strength with certain external conditions, is desired.

Firstly, the evaluation of the material as a pavement component will be discussed. Primarily the design philosophy (flexible, semi-flexible or rigid pavement) will decide the type of test required. Herein the flexural qualities of lime-pozzolan-soil mixtures will be ignored and

the subject will be treated by flexible pavement theory, utilizing only the shear resistance. In granular materials where the condition of the void filler determines the frictional properties of the material, some form of triaxial (say vacuum) or the C.B.R. Test will provide the shear strength, but confinement of sample is needed. While for fine grained soils such as normally found in subgrades, the C.B.R. Test or any type of strength test that has been correlated to design curves can be used to indicate the strength of lime-modified material. The basic approach is to measure both the frictional and cohesive components of any increase in strength due to modifying action by additives, separate from any strength increase caused by the cementing effects of lime-pozzolan. The strength increase with time due to cementation can be checked for permanency, and any reasonable portion can be used. This of course, assumes that while all of the cementation effect may be lost by lack of durability, the modifying action is permanent. Obviously the "permanent" strength must be determined before time allows any appreciable cementation to occur. After this some form of unconfined compression test

(end bearing or diametral bearing) can be used to determine the degree of cementation, as cohesive materials gain little or no strength from confinement. The surface tension of interstitial water will have a cementing effect, depending upon the amount filling the voids.

If durability is considered as the ability to retain original characteristics then any characteristic of the sample can be selected as a measure of weathering and an empirical relation found after sufficient pertinent results are compiled. The Portland Cement Assoication weight-loss test (Wet-Dry D.559 and Freeze-Thaw D.560) is one empirical weathering test that has been developed for soil cement. Work by Whitehurst and Yoder (1952), with the non-destructive sonic method of evaluation the modulus of deformation shows promise. Also, the British freeze-thaw test using unconfined compressive stress as the indicator, can be used. The Portland Cement Association "exfoliation" measure method has been found to be too stringent for lime-pozzolan-soil mixtures and requires both large quantities of materials for samples and large freeze-thaw cabinets. The Modified British Method as outlined in Appendix "A", is one attempt to circumvent the above drawbacks. Later

modifications have been made to allow the water in the thermos bottle to be kept at a constant temperature by the use of a light bulb. One additional advantage of the Modified British Method is that the frost lensing suceptibility of the lime-pozzolan-soil mix can be evaluated. Summarizing, the foregoing indicates that the Portland Cement Association weathering test is a surficial test, while the sonic test measures average conditions in only one dimension, leaving only the unconfined compression test to measure the weakest condition of cohesion.

Whatever the testing method the laboratory results should closely predict local field performance and particularly not be overly optimistic as this can lead to embarrassing design failure. This failure would unfairly discriminate against the use of lime-pozzolan mixtures in future work.

V VARIABLES AFFECTING STRENGTH AND DURABILITY

Density is one of the most important variables affecting strength and durability of lime-soil and lime-pozzolan soil mixtures. Generally, an increase in density results in

an increase in strength, at one single additive content. Remus and Davidson (1961), found that strength gains from twenty to fifty percent occurredby increasing the density from Standard to Modified Proctor, with various soils and limes. Over-compaction of silts can produce loss of strength due to swelling but there is limited evidence that if sufficient additive is present, regrowth of strength will occur. The more densely the particles of soil are packed the less "glue" is required and the same amount tends to be stronger, and therefore, more durable.

Availability and accessability of additives is very necessary for strength growth. The greater the surface area of pozzolan and of lime, the more rapid the reaction. But this material must be dispersed and space be available for bonding to occur between soil particles. Baker, C.N. (1954), working with soil cement and a specially made pugmill type of laboratory mixer disclosed that there was poor correlation of laboratory and field results due in large part to poor field mixing. Domaschuk (1960), also stresses this point. Goecker and colleagues (1956), also indicate the effect of mixing time on compressive strength. The degree of uniformity of mixing will depend on such variables as type

of mixer, water content during wet mixing, amount of charge, type of constituents, length of mixing, plus several other minor variables.

Temperature is another very important variable and is at the crux of the durability problem in northern climes. Several investigators have indicated that the rate of pozzolanic reaction and strength growth vary directly as the temperature from twenty to sixty degrees centigrade. There is some doubt about the durability of mixtures cured above forty degrees centigrade (104° F). One of the chemical effects of raised temperature is to decrease the solubility of calcium hydroxide and increase that of the magnesium hydroxide. At low temperatures magnesium oxide hydrates more slowly but calcium oxide is not affected. This may well influence the durability by the rate of crystal growth and solution replenishment. Ground field temperatures are difficult to predict in the first few feet of depth because of the numerous variables, such as snow cover type of soil, density, moisture content etc. Daily temperature changes penetrate only two or three inches into the pavement indicating that the monthly variation with its characteristic time lag is the important factor.

This would indicate that the early frosts would not penetrate to the subgrade if some material was present above it. Raised curing temperatures in the laboratory require closer control for both time and temperature if consistent results are to be achieved. It is felt by some (Leonard and Davidson, 1959), that at temperatures below twenty degrees centigrade, little if any strength growth occurs (See Fig. 2).

Weathering effects such as wet-dry cycles and freeze-thaw cycles upon the cohesive strength must be known if the design is based upon strength of laboratory cured samples. Investigations by Minnick and Miller (1950), illustrate that optimum amounts of additive greatly enhance the freeze-thaw and wet-dry resistance, particularly in the samples cured the longest. Hoover, Handy and Davidson (1958), working with a sand, a silt and a clay, found that wet-dry cycles in some instances greatly increased the compressive strength. They also found that freeze-thaw tests were in some instances beneficial for the first several cycles but then after that the strength behaved erratically and usually decreased slightly. The choice of twelve cycles of freeze-thaw may be too severe

while the choice of the same number of wet-dry cycles may not be sufficiently severe. Though no mention is made of this item, it is believed that the location of the lime-pozzolan-soil mixture whether in the sub-base or in the base course will be an important factor in weathering resistance, and in the testing procedure.

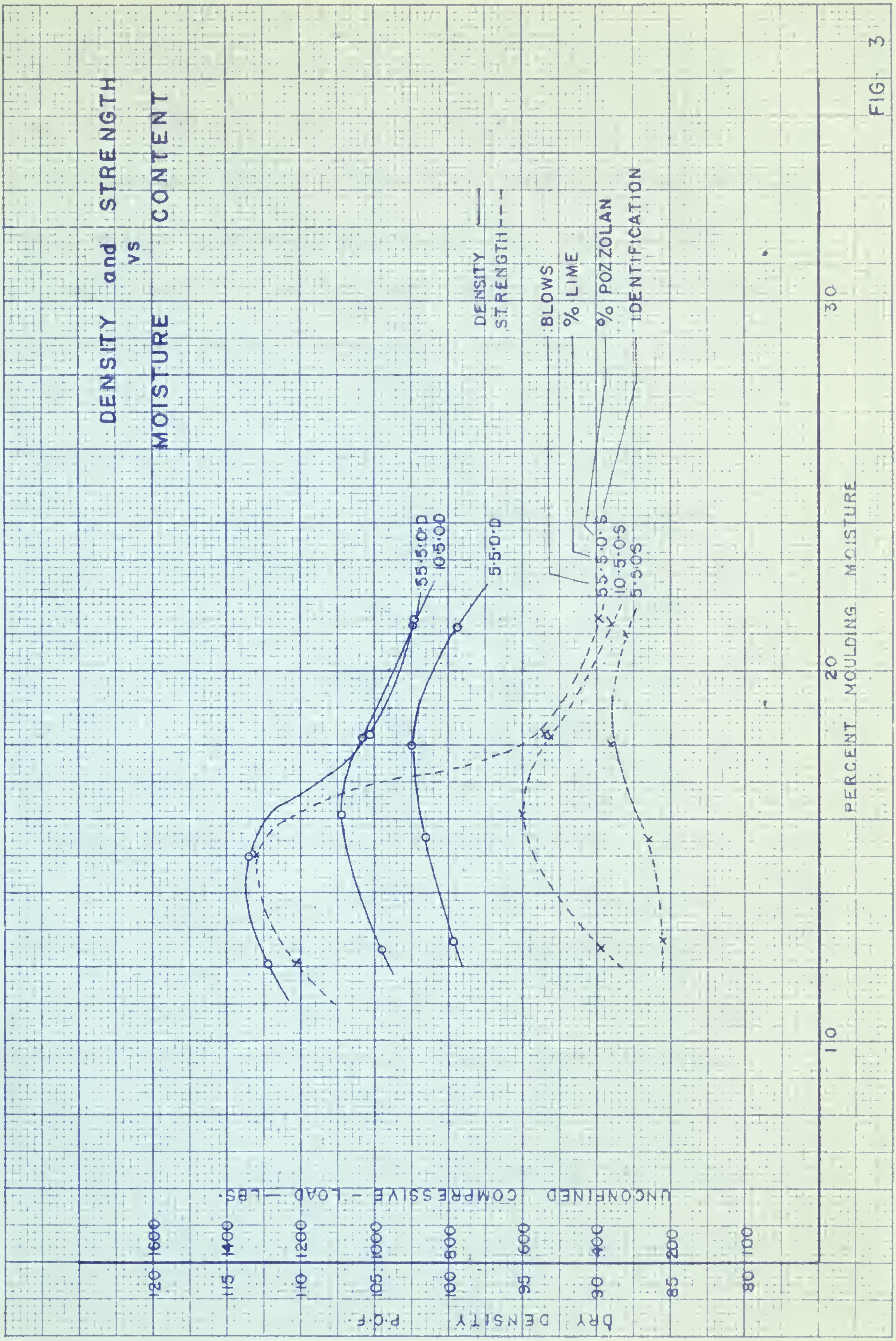
Curing conditions both in the laboratory and in the field are quite important. As outlined in the previous paragraph, varying moisture conditions will cause an increase in compressive strength. The effect of varying the curing temperature above the freezing point is unknown. Carbonation of the mix by exposure to atmosphere is deleterious to the long term strength increase, even though early strengths are little effected (Goecker, 1956). The last mentioned investigator found that for a silty soil and a clayey soil, complete submergence of test samples after moist curing provided a large increase in compressive strength over that of only moist curing, particularly greater for those samples moist cured the longest. In view of all this uncertainty about the effects of moisture, laboratory samples should be cured at one hundred per cent humidity or

in a standard sized closed container. The latter would be done to control condensation losses.

Selection of the moisture content for optimum strength is most easily solved by using the optimum moisture for maximum density even though the maximum strength is usually on the dry side of this point by about one to three per cent. The difference can be considered to be minor. A pilot test upon an oven-dry set of lime-pozzolan-soil samples provides an indication of the strength results expected in this investigation (See Fig. 3).

VI STRENGTH ACCELERATORS

Because of the short periods of warm weather in extreme northern regions some method of increasing the strength growth of lime-pozzolan-soil mixtures must be found if satisfactory freeze-thaw resistance is to be obtained for these regions. Trace quantities of chemicals (one-half to one per cent) appear to be the best method of strength acceleration. Forty-seven chemicals were evaluated by Davidson, Mateos and Katti (1959), with a silica sand as the inert "soil". Many of these chemicals benefited the strength, particularly in the long term, but


DENSITY and STRENGTH
vs
MOISTURE CONTENT
DENSITY
STRENGTH
BLOWS
% LIME
% POZZOLAN
IDENTIFICATION
55·5·0·D
10·5·0·D
5·5·0·D
55·5·0·S
10·5·0·S
5·5·0·S
PERCENT MOULDING MOISTURE
10
20
30
DRY DENSITY P.C.F.
UNCONFINED COMPRESSIVE LOAD — LBS.
80
85
90
95
100
105
110
115
120
100
200
400
600
800
1000
1200
1400
1600
FIG. 3

either method of application, cost or some other factor, made many of these unsuitable. In further evaluation, Mateos and Davidson (1961), chose four sodium compounds. They found soidum carbonate the most advantageous for silty and sandy soils but as the clay content increased, the effect of the accelerators decreased, even to the point of being detrimental with montmorillonites. Previous work by Iowa investigators was performed using another set of four accelerators - sodium hydroxide, sodium carbonate, sodium silicate and calcium chloride, in an attempt to harden the surface of lime-pozzolan-soil mixtures for tertiary road surfaces. One interesting aspect was that the use of the powdered form proved the most beneficial. Work by Davidson, Mateos and Katti (1959), indicated that while calcium chloride accelerated the strength, it also greatly decreased the freeze-thaw resistance. Evidence exists that with some strength accelerators, the amount used must be measured accurately as any excess is detrimental, e.g. phosphoric acid. The present status of accelerators appears that they are suitable for sandy and silty soils, but not so useful for clayey soils. In view of the chemical

variation in different components of the lime-pozzolan soil system and the effect of various trace chemicals on strength, it would appear likely that strength accelerators would have to be evaluated for each phase system independently for the present.

VII FERET'S GRANULOMETRIC THEORY OF STRENGTH

The science of granulometry was founded by Feret[1] in connection with his classical work on hydraulic mortars (4) and was largely used in the field of concrete proportioning by Fuller, Abrams and Rothfuchs.

Preliminary evaluation of this theory indicates a possible avenue of approach to an intelligent design of lime-pozzolan-soil mixtures. The following excerpt from Winterkorn (1957), outlines the basic idea.

> Granulometry is concerned with size, shape and gradation of particles; their arrangement and packing into multiparticulate uncemented or cemented systems; and the physical properties of such systems as influenced by particulate components. --- However, as Feret already stated, the principles of granulometry are of a geometrical character and not bound to a particular grain size range. They hold for coarse and fine aggregates, for silt and clay materials and even for systems in which the effective particles are atoms and molecules, as in liquid melts or in crystal solids.

[1] Feret, R. (1892) "Sur la compacite des mortiers hydrauliques", Annale des Ponts et Chaussees, Memoirs 7, Serie 4 p. 5 - 164.

Abram's water-cement ratio is the development of a specific form of Feret's general strength law. The latter can be expressed:

$$S = K \left(\frac{c}{1-s}\right)^n$$

$$\text{or } \log S = \log K + n \log \left(\frac{c}{1-s}\right)$$

where

S = compressive strength

K = essentially the strength of the cement but influenced by material and packing

c = absolute volume of the cement

s = absolute volume of the sand; and

n = constant depending on material and geometrical factors.

Winterkorn indicates that sand in this particular instance requires satisfaction of the surface absorption by asphalt before the foregoing relation can be applied. This would be comparable to the lime fixation capacity as outlined by Hilt and Davidson (1960), for lime-pozzolan-soil mixtures. On the basis outlined it appears that no particular problem is anticipated in developing a suitable design system for materials in which the addition of the cementing agent will

not modify the soil (sand) component. The aggregation or "flocculation" of clays indicate that the changing gradation with increased lime content may pose problems in applying this theory.

VIII RESUME OF PREVIOUS LOCAL RELATED WORK

In the following paragraphs the work of four Civil Engineering Master's Theses completed for the University of Alberta, will be very briefly summarized, to provide some inkling of what research has been performed, which may apply to the existing investigation or aid in future ones.

In 1958, J.G. Clark, investigated a minus three inch GF gravel with and without additives. The test apparatus was a twelve inch diameter by twenty-four inch high, vacuum triaxial type. Using two percentages each, of Portland Cement and of lime-flyash additives, with short curing periods, he arrived at the conclusion presented briefly in part here.

(a) All admixtures investigated improved strength and plasticity characteristics.

(b) Cement-treated samples had decreased optimum moisture contents and increased dry density, while

(c) lime-flyash treated materials had increased optimum moisture contents and decreased maximum dry density.

Apparently a continuation of Clark's research was the basis used by K.A. Millions (1959). He investigated two gravel sources of various maximum sizes. Generally it appears that he found that the low permeability of the fines caused the losses in strength of a saturated gravel. In the second part of his investigation he determined the effect of time upon Liquid and Plastic Limits of the fines portion of the same material as used by Clark, when additives were present. He determined the following facts:

(a) There was no further increase in plastic limit above a certain minimum of cement additive, at zero curing time.

(b) As the curing time increased, both the Liquid and Plastic Limits increased at a constant rate with no change in Plastic Index.

(c) With lime-flyash after the initial reduction in plastic index there was a reduction in both plastic and liquid limits at first, then an increase as curing time increased further. This sag in the liquid and plastic limit curves was more pronounced at higher lime-flyash additive contents.

In the summer of 1959, T.S.W. Harvey (1960), further continued the work of Clark and Millions by attempting to obtain D'arcy's permeability coefficient for a minus three inch gravel used by Millions. He found that permeability was an elusive quantity and affected greatly by several variables. He felt that additives had minor influences compared to the other variables but did increase the permeability somewhat. In the second part of his investigation, he indicated that cyclic freezing and thawing of additive-treated-minus-forty-sieve-size material had a further beneficial effect on the plasticity characteristics at the higher amounts of additive in regards to strength. Actually, the graphical plots indicate a small increase in plastic index with increasing cycles of freeze-thaw of <u>lime</u> <u>flyash</u> mixtures only. Harvey also stated

that to secure permanent beneficial changes from the lime-flyash additive, over five per cent by weight, must be used (of this particular type and ratio). He also made several other pertinent observations but brevity and lack of direct application to this investigation make the omission necessary.

In the review of work so far, evaluation of an additive's effect on retention of strength in compacted samples is not given; only the effect on the modifying actions as indicated by Atterberg Limits.

While not directly related to lime-pozzolan-soil research, Domaschuk (1960), established by his investigations several items that appear to have direct application in this field. The following excerpt is generally in his own words but with some changes for the sake of continuity and brevity.

(a) There is a definite relationship between density and compressive strength (of soil-cement).

(b) A time lapse between mixing and compacting the cement:

(i) increases the compactive effort required to maintain a constant density;

(ii) does not affect the compressive strength provided the density is kept constant:

(iii) decreases the density and compressive strength if the compactive effort is kept constant.

(c) Breakdown of sandstone under compaction weakens the soil-cement (granular particle failure).

(d) Dry density increases with hydration of cement.

(e) Fractured soil cement regains compressive strength with time, if loading is discontinued.

(f) The properties produced in the laboratory can be duplicated in the field providing close control is excercised over gradation, cement content, and density.

(g) Compressive strength can be used as a criterion of the soil-cement's ability to withstand exposure to the elements.

It has been stated elsewhere in this text that loss of strength due to overcompaction of a silt was regained in twenty-one days. Also, it has been noted that the amount of mixing and the moisture content will largely influence the results achieved in both the laboratory and in the field. Baker (1954), in his article points out the need for control of the mixing operation in the field and suggests a compromise be made in the field between adding more additive and increased mixing of the components. This generally agrees with Mr. Domaschuk's work.

While the preceding has not contributed directly to the main topic of this thesis, it has provided a brief review of local work in the general subject of lime-pozzolan additives and will help to delineate further research.

CHAPTER V

TESTING PROCEDURES

I FABRICATION

The soil was obtained from an area of Highway 16 immediately west of Edmonton. This area appears to be a kettle lake type of terminal moraine topography. In the laboratory the soil was air dried and disassociated in a Los Angeles Abrasion machine. The original soil contained no more than ten per cent retained on the No. 4 sieve and twenty per cent on the No. 40 sieve. Since lime-pozzolan mixtures would be used to modify and cement soil binders of low plasticity, and since the Atterberg classification tests were performed upon material passing the No. 40 sieve, the test sample was sieved through this size. The resulting soil was a CL to a CI material by the Unified Classification System or A -6 (9) by the A.A.S.H.O. classification (Designation M145-49).

The optimum compressive strength of soil plus additives was assumed to occur at the optimum density-moisture condition. This while not quite true, was accepted as being sufficiently accurate in view of the

problem with control of optimum moisture. The method used to determine the moisture content at optimum density for each mixture of lime-pozzolan-soil was as outlined by Goecker (1956), in the appendix to his article. Briefly this consisted of a triangular chart similar to the Textural Soil Classification where the three components were soil, lime and pozzolan with superimposed contour lines of optimum moisture content plotted. Some liberties were taken, as indicated by figure 18, in simplifying the diagram. For each compactive effort three moisture density relations were obtained. That of natural soil, soil plus forty percent (by weight) of pozzolan and soil plus forty percent (by weight) of lime. Any intermediate mixture of the three components was assumed to be related by straightline proportions. While this is not actually true, particularly for the low lime additive contents, the probable error was assumed to be within the range of allowable moisture variation. A pilot test of moisture-density-strength relations when soaked twenty-four hours before testing indicated that:

(a) Natural soil samples would disintegrate within two hours when submerged in water.

(b) Even a small amount (5% by weight) of lime would prevent this disintegration.

(c) Unconfined compression tests provided a peak in the strength-moisture curve of sufficient flatness to allow little change over a range of two to three per cent moisture.

Because of the large number of samples which were to be used, such problems as amount of soil required, amount of compactive effort expended, storage area required and the configuration of the original freeze-thaw equipment (figure 4), it was considered advisable to adopt a sample size smaller than the usual Standard Proctor Mold. This approach was previously used by the Iowa State University, therefore, many of their ideas were assimilated in the testing procedure followed. This included size of compacting, measuring and testing equipment, method of measuring density of prepared samples and, method of curing and testing.

A sample of air dry soil was removed from a one hundred pound sack stored under normal humidity conditions. Previous to being stored in sacks, the soil was

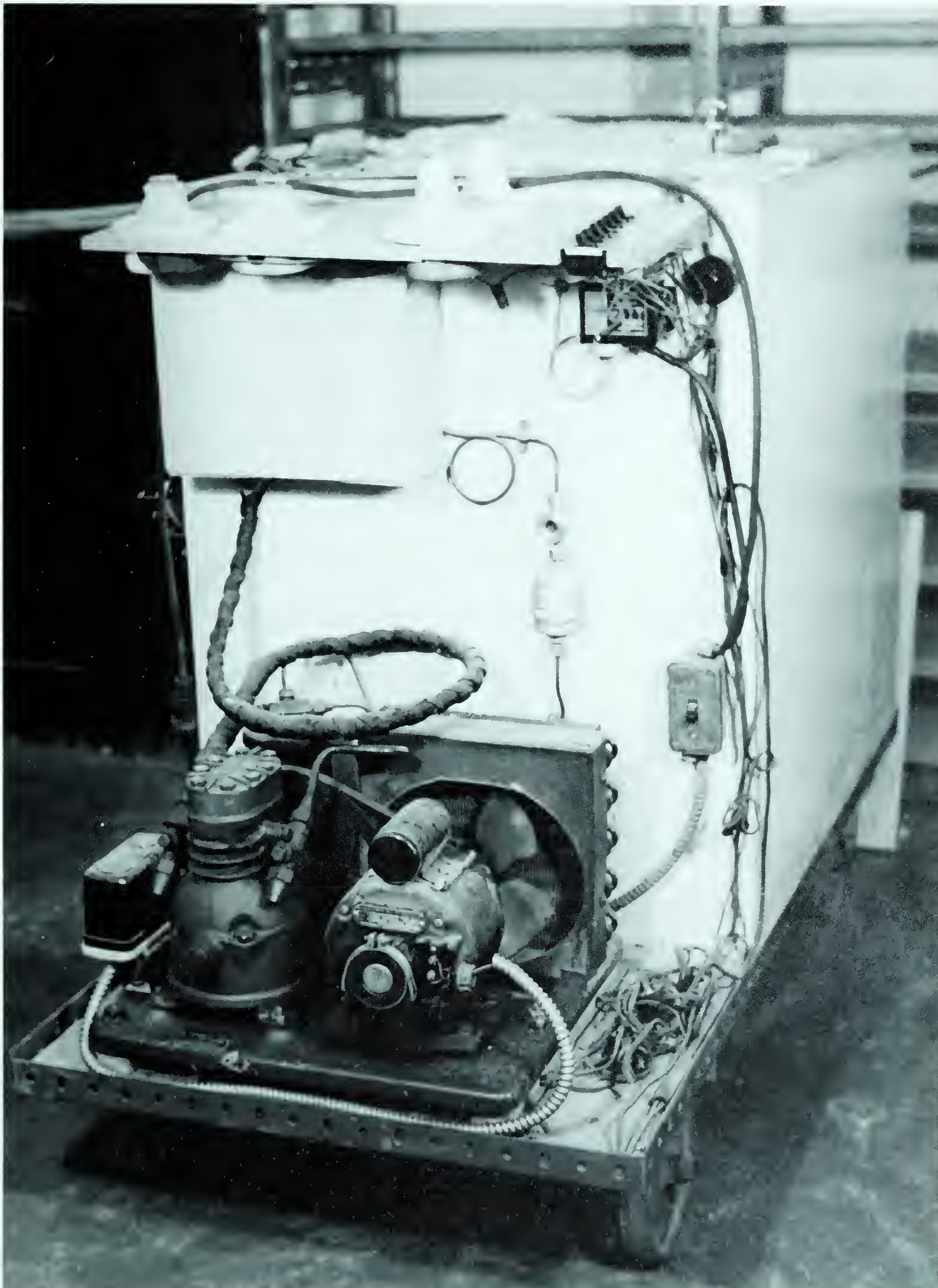


Figure 4 - Basler's controlled temperature cabinet used for Freeze-Thaw Tests

mixed in a mortar boat until it was uniform. The Diamond City calcined shale (pozzolan) was stored in one hundred pound paper bags with no protection from natural humidity. Only the commercial hydrated lime was stored in two quart glass sealers to prevent carbonation. The three components of lime, soil and pozzolan were individually weighed to one gram accuracy, in sufficient quantity to provide eight compacted samples per batch. This permitted one for a moisture content determination and one to determine the weight per sample for the permissible compacted height of 2.000 ± 0.050 inches. The three components were mixed dry for thirty seconds in a "Reco 212, 2 speed" mixer, set at a slow speed (figure 5). The predetermined volume of water was added, permitted to soak for thirty seconds and the sample was then mixed for three and one-half minutes. The mixer was stopped and the soil adhering to the bottom of the mixing bowl was hand mixed with a spoon into the entire mass. Then the material was machine mixed for another thirty seconds.

The bowl was covered with polythene plastic while the subsequent weighing and compacting proceeded.

Figure 5 - Reco two speed mechanized sample mixer

Once the proper weight-height ratio was determined, six individual samples were weighed and stored temporarily in separate polythene bags. One at a time, each bagged sample was deposited into the 2" I.D. by 4" deep compaction mold. The mold was shaken several times to level the surface. The full weight of the compaction hammer was allowed to rest on the soil sample for about five seconds, then one blow of the five pound weight was applied. The V shaped mold support was removed (figure 6). Then the remaining blows were applied to that face while the mold was in a "free floating" condition. The mold was inverted on the compaction pedestal and the appropriate number of blows applied to the opposite sample face. The sample was labelled by scribing on one soil end and then it was removed from the mold with a hydraulic ram, weighed to 0.01 grams and measured in height to 0.001 inches. Then the compacted sample was flame sealed in a moistened polythene bag and stored for twenty-eight days in the concrete curing moisture room (about one hundred percent relative humidity) at a temperature of 70 ± 3 degrees Fahrenheit. During fabrication of samples a moisture content was taken after the third sample and this was used as the average moulding

Figure 6 - Modified compaction apparatus

moisture of all six samples in computing dry density. The dry density at fabrication was computed from the following:

$$\gamma_d \text{ lb. per cu. ft.} = \frac{1.210 \text{ Wet Weight - gms.}}{(1 + W) \text{ Sample Height - ins.}}$$

No reliable indicator of moisture variation between the samples of one batch was available. An indication of the variation could be determined from the difference in designed and actual moisture contents, but this also varied with room condition from test batch to test batch. Each set of six samples for a singular value of compactive effort, additive content, and lime-pozzolan ratio, were completed in a time interval of thirty to forty-five minutes from mixing to storage.

II SUMMARY OF CONSTITUENT PROPERTIES

A Soil

The minus forty sieve portion equals eighty percent of original sample.

M.I.T. Sand sizes (+0.06 m.m.) = 20%

Silt sizes (+0.002 m.m.) = 65%

Clay sizes (-0.002m.m.) = 15%

Liquid Limit = 32.7%

Plastic Limit = 19.3%

Plastic Index = 13.4%

Specific Gravity = 2.74

B Lime (Loders[1])

Chemical Analysis

	Loders Lime	Provincial Analyst
Ignition loss	22.9	25.43
SiO_2	0.3	1.01 incl. insolubles
FeO_2)) AlO_2)	0.4	0.38
MgO	1.2	2.42
CaO	74.8	70.40

Sieve Analysis

Sieve Size	Percentage Passing
35	100
60	100
100	99.0
120	98.6
170	98.0
200	96.8

Specific Gravity = 2.25

[1] Loders Lime is a manufacturer's brand name and is made at Kananaskis, Alberta.

C Diamond City Shale[1] (Pozzolan)

Calcined by spontaneous combustion, ground to following gradation.

Chemical Analysis[2]

SO_2; Al_2O_3; Fe_2O_3	85.9%
MgO	1.3%
SO_3	1.3%
Loss on Ignition	1.2%
Moisture Content	0.58%
Retained on #325 sieve	9.5%
Specific Gravity (personal determin.)	2.74

1 One of the suburbs of Lethbridge, Alberta, can be considered to be Diamond City Shale.

2 This is a private communication from Western Minerals Ltd. to the Alberta Research Council.

III TESTING

After twenty-eight days curing, the samples were removed from their protective wrapping and soaked for twenty-four ± two hours in distilled water at a temperature of seventy ± three degrees. Each sample was removed from the water, surface dried, measured for height by use of an Ames dial and then tested in a motorized "constant strain" testing stand (figure 7). The strain applied theoretically was 0.10 inches per minute or 0.05 inches per inch of sample height, but, "slippage" of the electric motor due to load, and deflection of the moving ring at high loads varied this from 0.07 inches to 0.09 inches per minute. The peak load value obtained was recorded as the failure strength. A representative moisture content was then taken from the sample to provide the "soaked moisture content". The constant strain method was used to simplify determination of optimum strength of each sample.

IV COMPUTATIONS

The dry density of the specimen was based upon the single average moisture content obtained during the

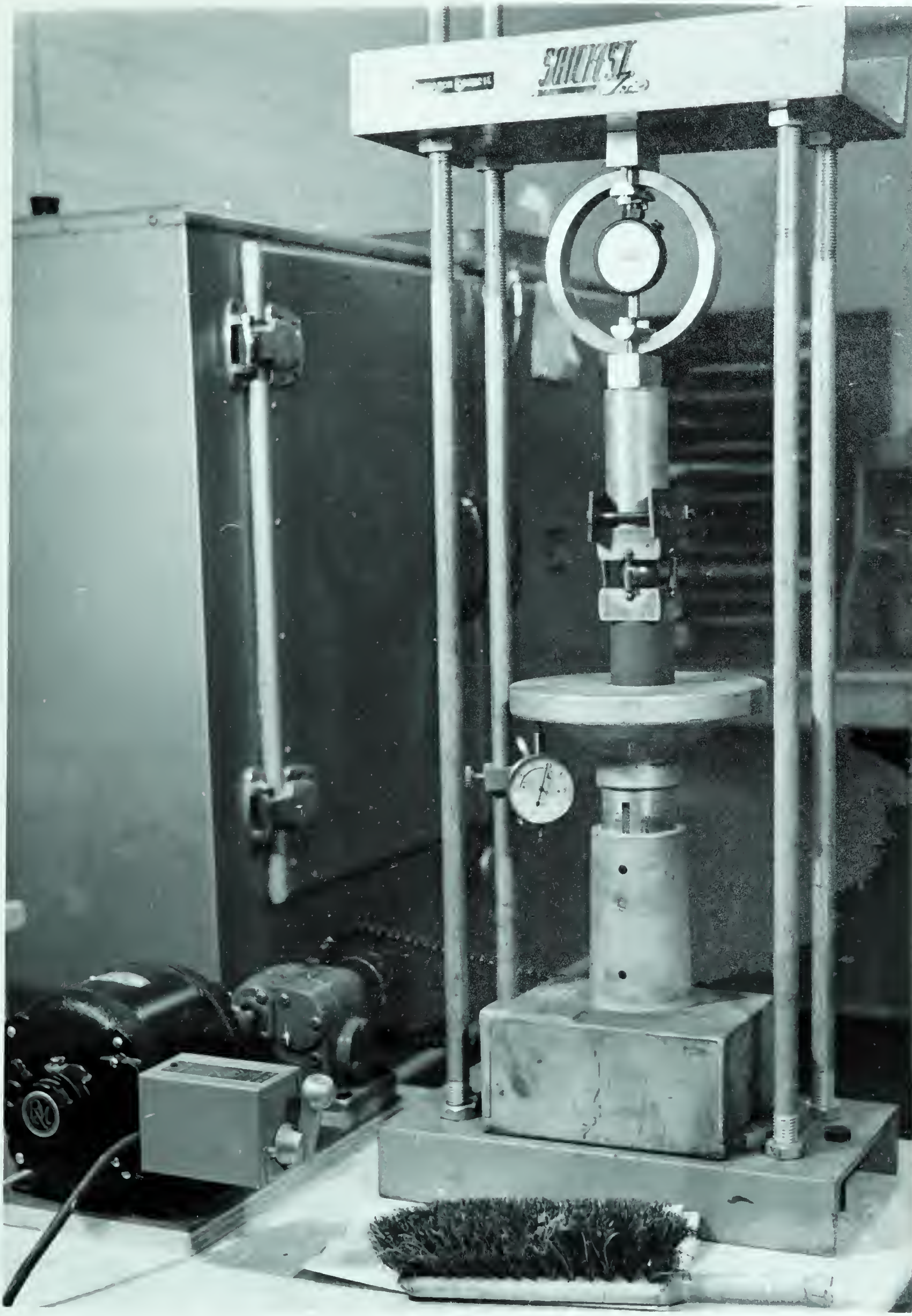


Figure 7 - Motorized constant strain compression frame

fabrication and the individual height measured for each sample. The diameter of several ejected samples was checked and found to be 2.00 inches, sufficiently accurate for slide rule accuracy. Although sample heights were measured to 0.001 inches, the expected accuracy was $\pm$ 0.005 inches and the computational usage was to 0.01 inches. Each sample was represented by a dry unit weight, an unconfined breaking load in pounds, a moisture content at failure, and a height preceding failure. The arithmetic mean of each of these items for each batch was recorded in the results section of the data sheet, with the exception of the soaked sample height. The average unconfined pressure for each batch was computed by the following conversion from the average unconfined load:

$$p = 0.318P$$

where p = p.s.i.

and P = load in lbs.

The values of volume of various components were determined on the basis of the group average dry unit weight, proportions of each additive on a basis of <u>total</u> dry mixture as designed, and the specific gravity of each additive as determined in classification tests. Once the volume of

constituents per unit volume of compacted mixture was known, the volume of voids which occupied the remainder, could be determined.

In this investigation the sample was made only two inches high. This was done to permit compaction in one lift to eliminate compaction planes which occur when more than one lift is used. This would require a correction factor of 0.85 to be used for a length diameter ratio of one, if true values of strength were required. Since the shear strengths were used as relative values, no correction was made.

V DISCUSSION OF TEST PROGRAM

The following will indicate the problems encountered and where possible a suggested improvement. This may seem to indicate that the program was not very successful. On the contrary, the testing program was very encouraging.

During proportioning of components, although no weight adjustment was made for the hygroscopic moisture, it was encouraged to remain constant, by method of storage.

For the lime and pozzolan the hygroscopic moisture was less than one percent while for the soil it was between one and two percent. It was felt that the extra effort of allowing for hygroscopic moisture would not provide any true increase in proportioning. The hygroscopic moisture was used as a compensation for loss of water due to drying during mixing and compaction operations. One of the more unsatisfactory items was the use of one average moisture content to represent the moulding moisture of all six samples at time of compaction. This quite probably contributed one of the largest errors present in dry density determinations. More moisture tests will provide a more accurate <u>average</u> but may not necessarily increase the accuracy of <u>each</u> sample density determination.

One of the minor variations was the non-perpendicularity of the two major surfaces. Here the hammer and base pedestal must fit the inside of the mold loosely to prevent an "air cushion" during compaction, particularly if moisture contents above optimum are employed. This looseness will cause non-perpendicularity if a slight eccentric movement exists. The end result being that height

measurements are less accurately determined.

Although no measure was made of the following effect, it was noted in preliminary testing that samples moulded above optimum moisture, when ejected by the hydraulic ram assumed a shape with a slightly disturbed centre. This most certainly disturbed the density as compacted. This would suggest a more rapid method of sample removal to lessen this disturbance. Considerable comfort can be derived from the fact that all of the main test samples were at or just below the optimum and no convexing of the top was noted.

One of the disadvantages of reducing the size of the compaction mold is the increase in perimeter friction per unit area. This may be the cause of the non-linear relation of the "Dry Density v.s. Logarithm of Compactive Energy", plot at higher blow counts (figure 8). The Iowa investigators sidestepped this problem by using a larger compaction hammer for the modified proctor density. This also decreased the time required to compact a sample and therefore promoted more consistent use of the compacting hammer. For this soil a minimum of five blows per face is

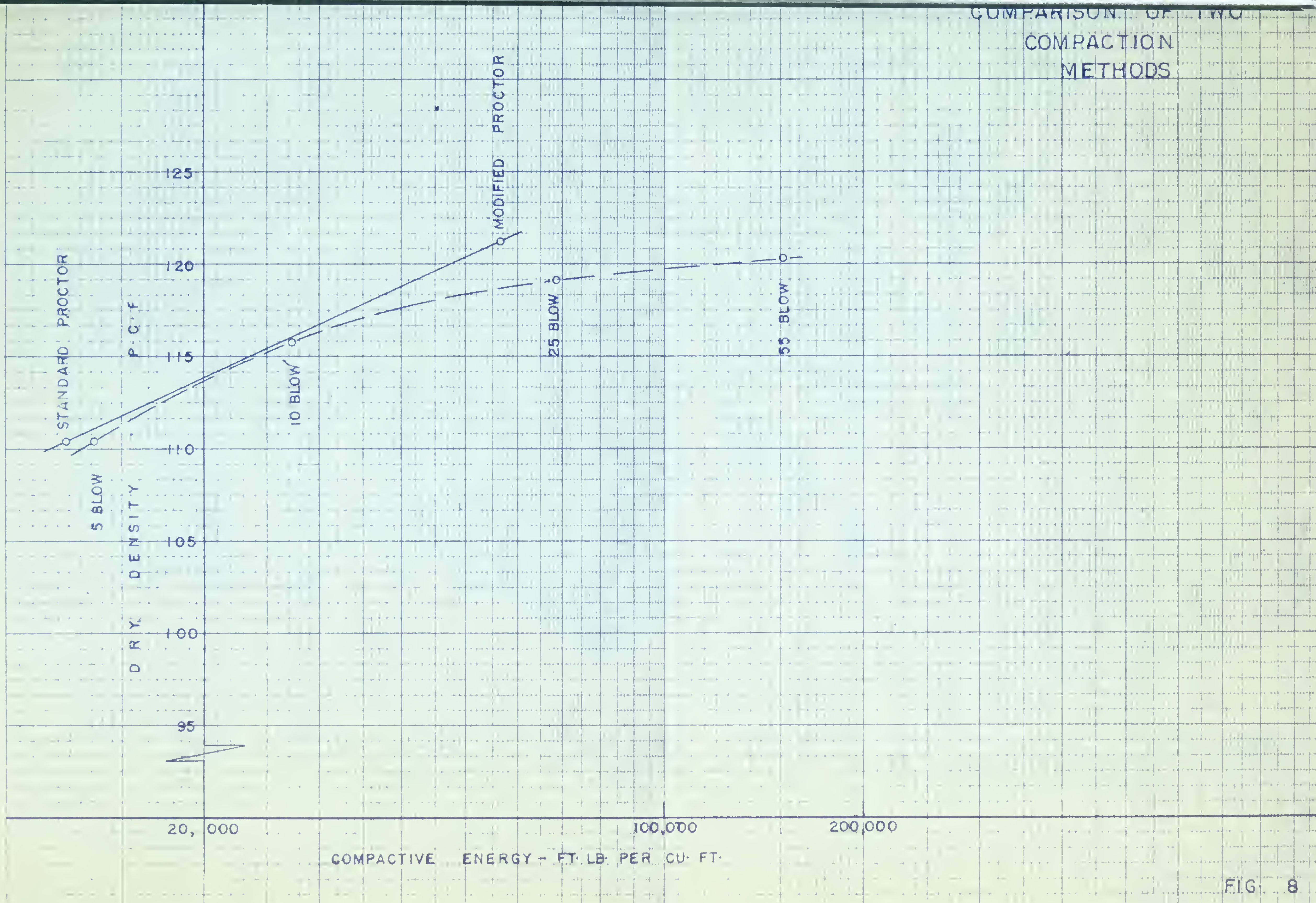

COMPARISON OF TWO
COMPACTION
METHODS
STANDARD PROCTOR
5 BLOW
10 BLOW
MODIFIED PROCTOR
25 BLOW
55 BLOW
DRY DENSITY P.C.F
125
120
115
110
105
100
95
20,000
100,000
200,000
COMPACTIVE ENERGY - FT. LB. PER CU. FT.

FIG. 8

necessary and a maximum of twenty-five blows per face is desirable. The first is required to obtain a uniform sample by minimizing the effect of small variables and the second is required to be economical of time and in some cases to limit the effect of perimeter friction. While the use of the "free floating" mold reduces the effect of perimeter friction, it can further be reduced by using a hard metal (steel, not brass or aluminium) to provide a smooth interior. Comparison of density of the natural soil compacted before and after the test program show no definite change due to increased smoothness of the interior of the molds.

The height measuring device (figure 9) which provided measurements of the centre of sample related to a standard unit (1.500 inches), could be improved by using two vertical supports and having a beveled edge sensing tip. The latter to prevent shaving of the soil when the sample is being moved about to seat it. Even then there is doubt whether the height can accurately be measured to 0.001 inches. Unless extreme care is taken height measurements can significantly be only recorded to 0.01 inches. Moving about of the sample in the "height tester" aided in seating

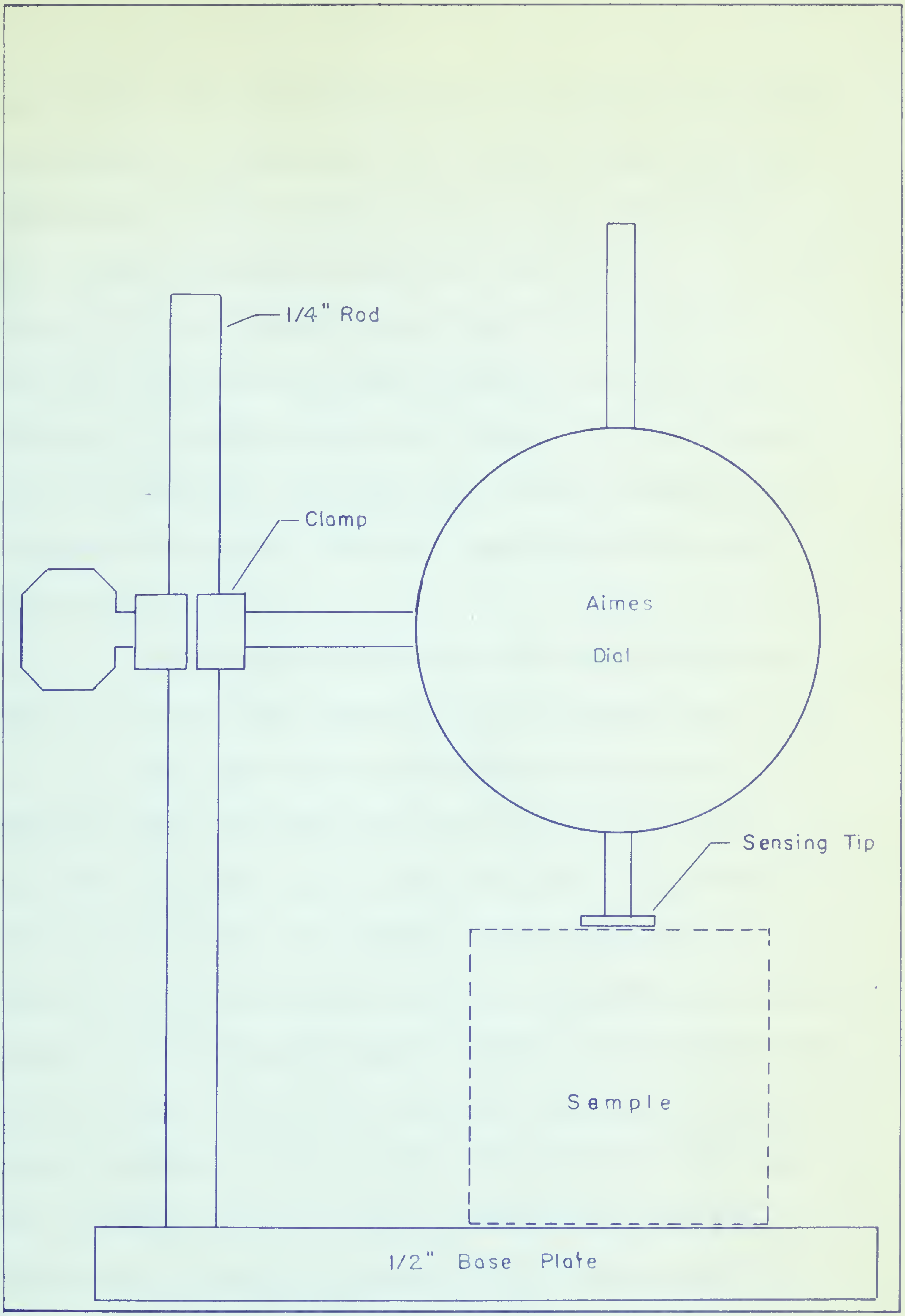


FIG. 9 HEIGHT MEASURING DEVICE

the contact and reduced the height by 0.005 to 0.01 inches. One alternate method tried with limited success was the measurement of the sample in the strength testing unit at a certain specified seating load (figure 7). Instrumentation problems caused the limited success. Because of the accuracy limits and the limited amount of swelling during prestrength-test soaking, the swelling item was not evaluated. For the main purpose of height determination, use of the height measuring device was satisfactory.

Normal precautions were taken to minimize the loss of moisture from samples during all operations.

The use of the two pound nominal size of polythene bags for handling of samples and for curing protection simplified greatly the procedure. The flame-sealed sample bags were airtight, except for about one dozen of the four hundred samples. These allowed water to seep into the bag and caused partial sample submergence during curing. Preliminary evaluation indicates no effect, either beneficial or detrimental. The inside of the bags were moistened prior to sample storage in an attempt to prevent loss of sample moisture by condensation upon the

inside. The effectiveness of approach is unknown but thought to be of limited use because of the variable air space in the sample containers.

Scribing the identification upon one end of the sample into the sample itself proved satisfactory in all cases except the freeze-thaw program, where sample disintegration defeated this method.

Solidness of the base on which the compaction equipment rested proved to be a major problem at first, providing erratic results. When the compaction equipment was firmly fastened to the base, reproducible results were obtained. This one item of variable compactive energy loss due to a loose base can lessen or completely destroy the accuracy of an investigation.

Although quite brief, it is hoped that this discussion of the test program will indicate both the approach and the potential problems for future investigations.

CHAPTER VI

PILOT TEST OF A MODIFIED BRITISH FREEZE-THAW TEST

I DESIGN CONSIDERATIONS

Originally the motive of this investigation was the determination of the factors affecting durability as obtained by freeze-thaw tests. Further evaluation of the available data indicated that this item would first require determination of the optimum strength of each lime-pozzolan-soil system for a more effective approach. Therefore, the thesis motive was changed to the latter field. In the meantime, since the freeze-thaw equipment had been partially completed, a preliminary evaluation of equipment was performed.

The controlling factor in the design of the equipment was the requirement of a maximum number of samples in a specified space as dictated by the size of the existing freeze-thaw cabinet (figure 4). The use of University of Iowa method was precluded by the number of thermos bottles required. The approach was basically similiar. It was to provide a container, with a source of

free water available to the bottom of each sample as the frost line descended vertically down through the sample from the exposed top surface. Three duplicate plywood boxes as shown in figure 10, were constructed with the lids being removable. Each lid contained three rows of six samples; each in fixed sample containers. Each container consisted of a polythene plastic tube of 2.06 inches inside diameter cut to a 2.1 inch length, having a bottom of clear acrylic plastic into which the tube was recessed and glued with contact cement. The bottom plate also had nine one-quarter inch diameter holes to allow free access of water into the sample. The boxes were constructed to fit into the freeze-thaw cabinet with the weight of the overlying box holding the lid firmly in place on the underneath box. Space was left to allow circulation of air about the outside ends and tops of the boxes to promote uniform water temperatures inside the three boxes. The three-quarter inch plywood, painted to water-proof it and to retain its insulating characteristics, was thought to be sufficient to prevent freezing of the water supply for each freezing period. Polythene tubing was used because of its low cost and non-brittle behavior at low temperatures. Preliminary

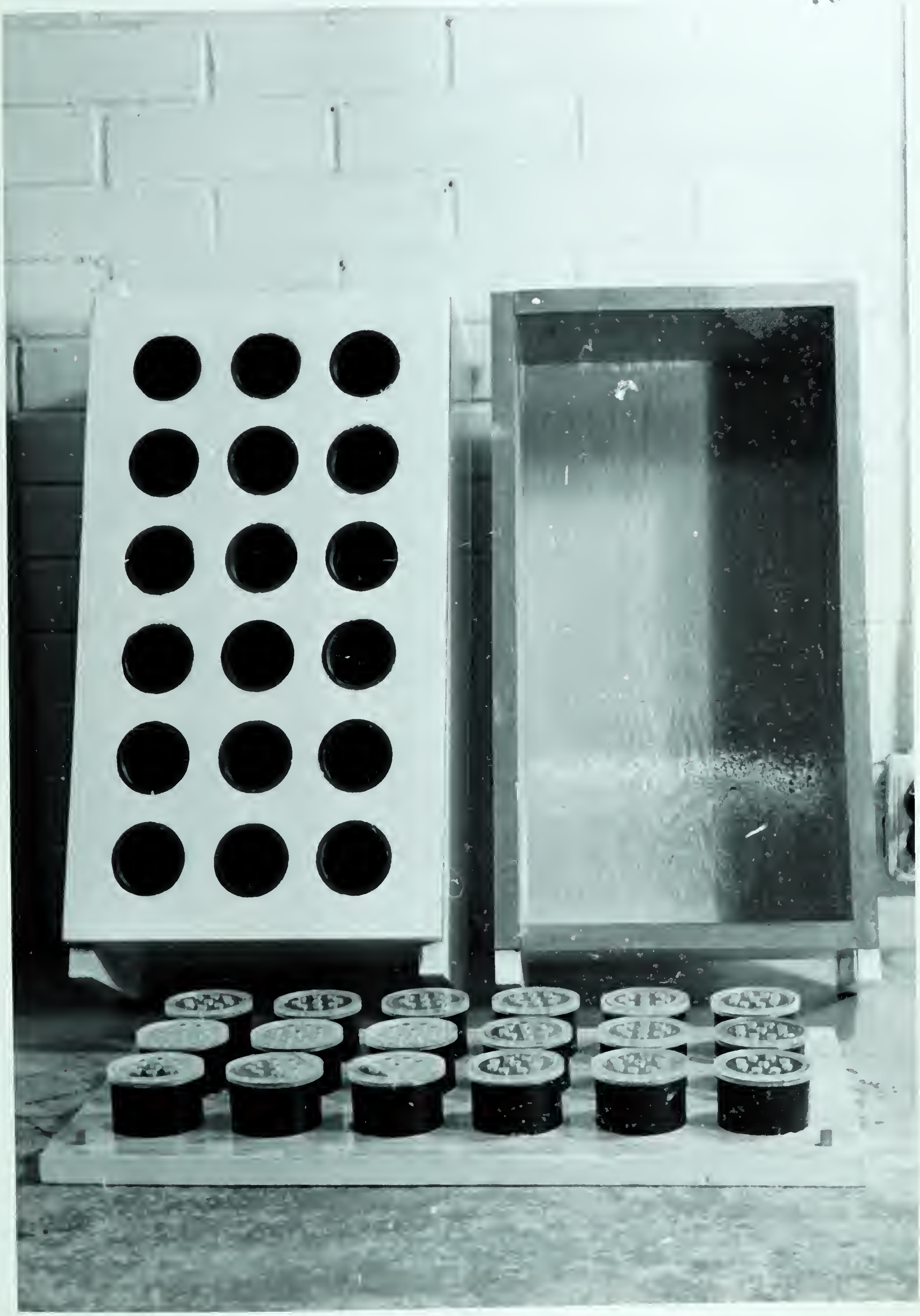


Figure 10 - Two freeze-thaw sample containers

tests indicated that contact cement would hold the bottom to the tube but this proved to be untrue during the actual testing procedure.

II DESIGN PROBLEMS AND SUGGESTED REMEDIES

The greatest problem was the construction of the sample containers. The polythene tube as supplied was too flexible to be easily handled in the lathe and was not truly spherical inside. When force-fitted into the wooden lid, the diameter of the end was reduced and had to be reamed to receive the sample. This left a rough inside surface and prevented the smooth removal of some samples. Also providing a more serious problem was the poor bonding obtained between two plastics (acrylic and polythene) with available cements at low temperatures, causing a subsequent loss of container base during freeze-thaw cycles. This allowed destruction of the samples by lack of confinement at the bottom during the thawing cycle. It is believed that loss of a firm support at the bottom of the sample prevented measurement of true frost heave (figures 11 and 12). Any variation in temperature between the top and bottom of the freeze-thaw cabinet was circumvented by

Figure 11 - Underside of sample containers with ice rime

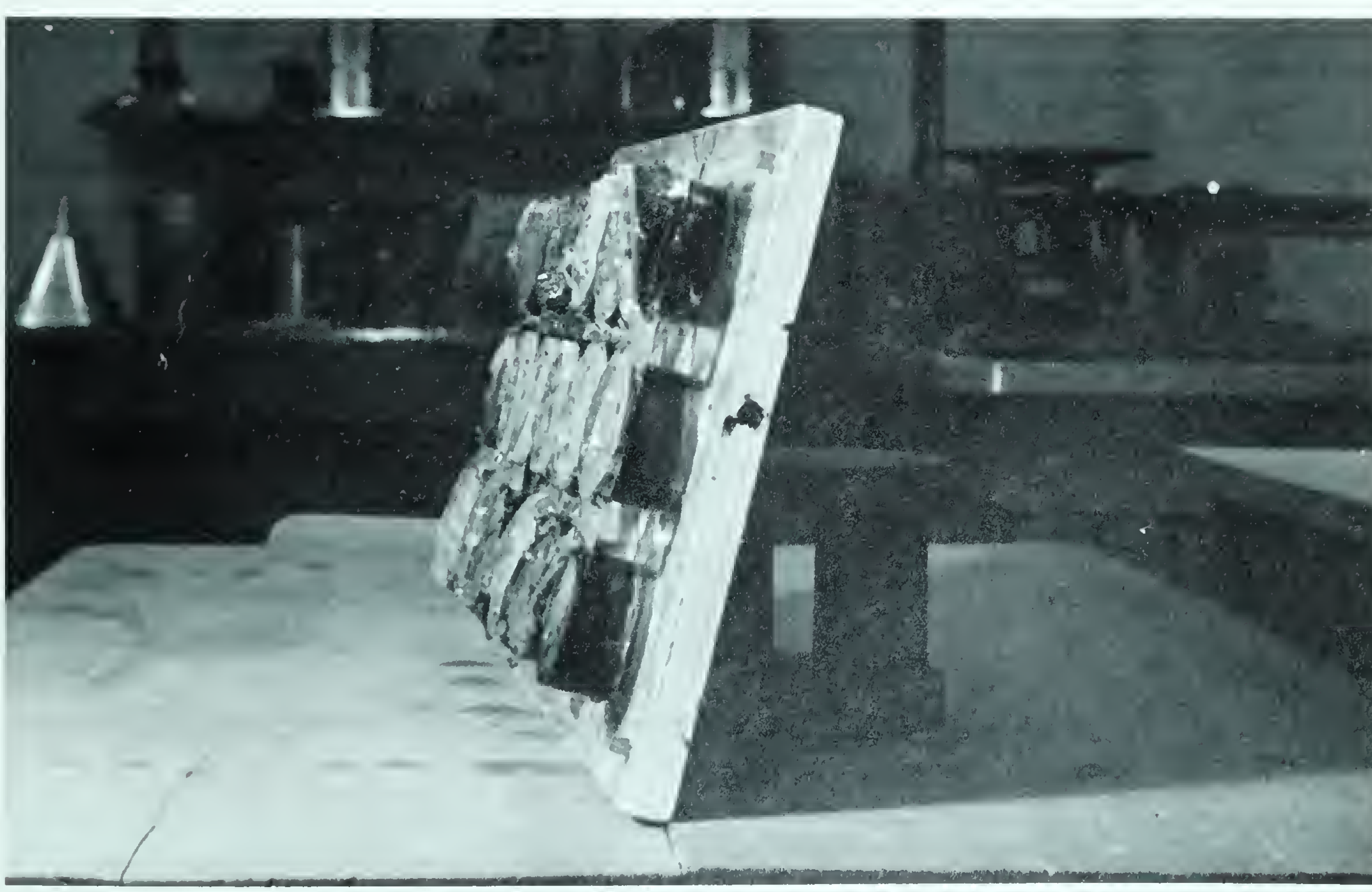


Figure 12 - Disturbance of sample bottoms from frost heaving

interchanging the position of the containers each day, that is reversing the order of placing into the cabinet.

III TEST PROCEDURE

Since the apparatus, rather than the samples was being evaluated, ninety-six specimens which were rejected from the main thesis program because of an error in optimum water content, were used as the test specimens. There were thirty-two samples in each of the three phases. The first phase consisted of the control samples being broken at the commencement of freeze-thaw testing. The second phase was the actual freeze-thaw test, while the third phase consisted of the control samples, experiencing no freezing, being broken at the end of the freeze-thaw test period. Each phase contained two samples from each series of unique design or test batch as previously named. The division of the control samples was to provide an indication of freeze-thaw effect and whether these were beneficial or detrimental in strength considerations.

The refrigeration cabinet was stabilized at the predetermined freezing temperature. The two sample boxes were filled with distilled water until the samples were

immersed to a depth of one-quarter inch and the boxes then set in the cabinet. The start and end of the freeze cycle was chosen at five p.m. and nine a.m., giving sixteen hours of freezing and eight hours of thawing. The thaw cycle consisted of the sample box being placed on the floor at normal room temperature. The freezing temperature was lowered each consecutive cycle to evaluate the procedure. Visual records were kept of sample behavior.

IV TEST RESULTS

At the end of each freezing cycle the water was at zero degrees centigrade and contained ice crystals but was not frozen at the surface; with the exception of the last cycle. The visual results are tabulated in table 2 and indicated in various photographs (figures 13, 14 and 15). All samples had been cured three to four weeks (table 1) before the start of the freeze-thaw tests but only one escaped without showing any disruptive influence of frost at the end of ten cycles. All samples indicated a unique type of failure. The failure planes were roughly horizontal and vertical resulting in cubical particles of one-quarter inch dimension in extreme cases. Two general

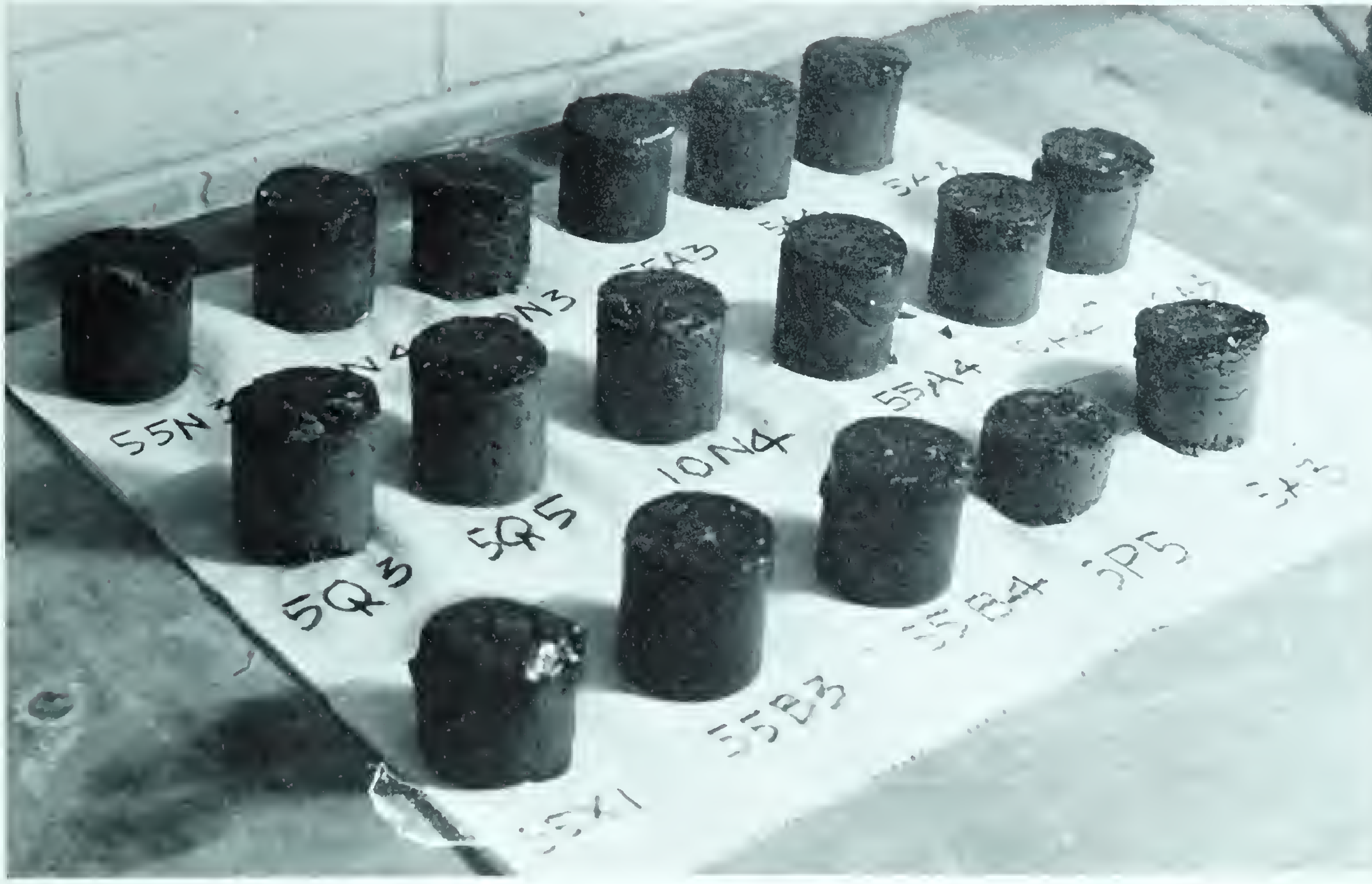


Figure 13 - Sample of some completed Freeze-Thaw

test cylinders

Figure 14 - Further view of Figure 13

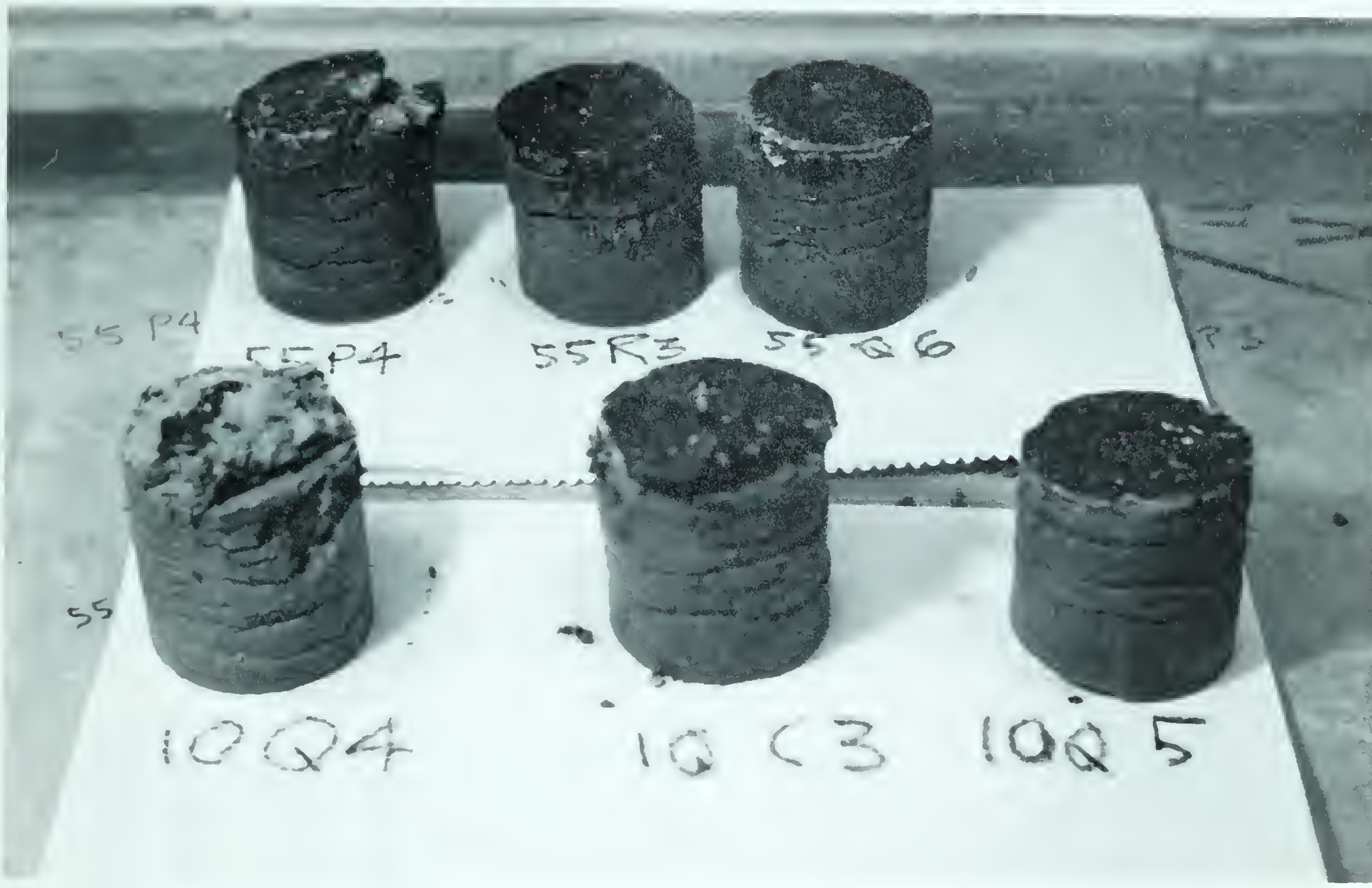


Figure 15 - Representative failure conditions in Freeze-Thaw samples

Figure 16 - Typical failure condition of compression test

TABLE I

SUMMARY OF SAMPLES AND CURING TIME

USED IN FREEZE-THAW PILOT TEST

Blows per face	Series	Date Made	Initial Control Sample	Initial Control Curing Days	Freeze-thaw Sample	Freeze-thaw Curing Days	Final Control Sample	Final Control Curing Days
5	A	23.1.61	1, 2	30	3, 4	41	5, 6	41
5	P	31.1.61	do	22	3	33	do	33
5	Q	31.1.61	do	22	3, 4	33	do	33
10	A	23.1.61	do	30	do	41	do	41
10	C	24.1.61	do	29	do	40	do	40
10	D	25.1.61	do	28	do	39	do	39
10	N	30.1.61	do	23	do	34	do	34
10	P	31.1.61	do	22	4	33	do	33
10	Q	1.2.61	do	21	3, 4	32	do	32
55	A	23.1.61	do	30	do	41	do	41
55	B	23.1.61	do	30	do	41	do	41
55	C	24.1.61	do	29	do	40	do	41
55	N	30.1.61	do	23	do	34	do	34
55	P	31.1.61	do	22	do	33	do	33
55	Q	1.2.61	do	21	3, 4, 6	32	-	32
55	R	1.2.61	do	21	3, 4	32	5, 6	32

TABLE II

FREEZE-THAW PILOT TEST

	Sample Heave in Tenths of an Inch										Post Test Data	
Cycle No.	1	2	3	4	5	6	7	8	9	10	Horiz. Failure Planes	Visual Sample Condition
Temp. Set. ^{o}F	23	23	25	23	20	20	18	15	13	10		
Prefreeze Temp. ^{o}C	-	-	9	9	9	9	8	7	5	-		
Sample												
5A 3	No heave				nil	nil	1	1	1	2	10+	Poor
5A 4	measurements				nil	nil	nil	1	1	2	10	Fair
5P 3	were taken				4	4	5	5	5	5	10+	Poor
5P 4	until cycle				1	1	1	1	1	1	-	-
5Q 3	5 although				1	1	2	2	4	4	10+	Poor
5Q 4	heaving was				1	1	1	2	2	4	10+	Poor
	noticed in											
10A 3	cycle 2				1	1	1	1	1	2	3	Good
10A 4					nil	nil	nil	nil	nil	nil	2	Excellent
10C 3					1	1	1	1	1	1	8	Fair
10C 4					6	6	6	6	6	6	3	Good
10D 3					4	4	4	4	4	4	10	Poor
10D 4					5	5	5	5	5	5	10	Poor
10N 3					nil	nil	1	1	1	2	N.A.	Poor
10N 4					nil	nil	1	2	2	2	10+	Poor
10P 3					4	4	5	5	5	5	-	-
10P 4					5	5	5	5	5	5	N.A.	Poor
10Q 3					2	2	5	5	5	5	5	Fair
10Q 4					4	5	6	6	6	6	10+	Poor

(Continued)

TABLE II (CONTINUED)

	Sample Heave in Tenths of an Inch										Post Test Data	
Cycle No.	1	2	3	4	5	6	7	8	9	10	Horiz. Failure Planes	Visual Sample Condition
Temp. Set. °F	23	23	25	23	20	20	18	15	13	10		
Prefreeze Temp. °C	-	-	9	9	9	9	8	7	5	-		
Sample												
55A 3					1	1	1	1	1	1	0	Excellent
55A 4					1	1	2	2	2	2	4	Good
55B 3					nil	nil	nil	nil	nil	nil	1	Excellent
55B 4					nil	1	1	1	1	1	1	Excellent
55C 3					nil	nil	nil	1	1	1	4	Good
55C 4					2	2	2	4	4	4	8	Fair
55N 3					1	1	2	2	2	2	8	Fair
55N 4					1	1	1	1	1	2	10	Fair
55P 3					2	2	4	4	4	4	7	Fair
55P 4					4	4	4	4	4	4	10	Fair
55Q 3					nil	nil	1	1	1	1	2	Good
55Q 4					1	1	2	2	2	2	5	Fair
55Q 5					1	1	1	2	2	2	-	-
55Q 6					nil	1	1	2	2	2	6	Fair
55R 3					nil	nil	1	1	1	1	4	Good
55R 4					nil	nil	nil	1	1	1	5	Good
55X 7					1	1	2	2	2	2	N.A.	Poor

TABLE III
FREEZE-THAW CONTROL SAMPLES

RATE OF CURING

	Initial Control				Final Control				
Series	Days Cured	Density P.C.F.	%Soaked Moisture	Unconf. Strength Lbs.	Days Cured	Density P.C.F.	%Soaked Moisture	Unconf. Strength Lbs.	% Initial Control Strength
5A	20	89.8	27.9	520	31	89.5	28.4	600	15
5P	22	91.7	23.8	235	33	91.8	24.0	290	23
5Q	22	87.5	28.5	280	33	87.3	28.3	350	25
10A	30	92.4	26.8	680	41	92.2	24.8	820	21
10C	29	96.2	21.5	500	40	94.4	23.4	510	2
10D	28	100.3	20.9	370	39	99.8	21.6	400	8
10N	23	98.9	21.6	350	34	99.0	20.3	360	3
10P	22	94.0	22.8	360	33	93.8	20.8	420	17
10Q	21	90.5	26.0	460	32	89.8	27.4	510	11
55A	30	99.2	22.7	1280	41	98.7	23.5	1400	9
55B	30	101.6	22.7	1440	41	100.3	22.7	1310	?
55C	29	102.2	20.5	980	40	102.1	20.8	1010	3
55N	23	106.3	17.6	640	34	105.4	19.1	810	9
55P	22	101.4	20.5	770	33	100.7	20.1	900	17
55Q	21	97.8	21.7	900	32	-	-	-	-
55R	21	99.4	20.3	800	32	98.9	19.7	780	?

NOTE: The above samples are rejects because the molding moisture was not that required for optimum density-strength conditions.

trends were detected. First, the samples with more additives were less affected, and second, the more highly compacted samples were less affected. The heaving at the top of the sample was caused by frost lenses because these were visible. Because of the loss of the bottoms of some sample containers, no definite amount of heave could be determined. There appeared to be another unique trend and this indicated that the samples about the perimeter edge of the box heaved more than those in the middle. Also, cumulative heaving appeared to diminish as the freezing temperature was lowered. None of the samples removed were in condition to provide a strength test, therefore, only the moisture content was taken. Upon completion of the last freeze-thaw cycle the soil sample containing no additives and compacted by modified Proctor procedures, was in a saturated "mushy" state possessing very little cohesive strength. The other samples containing lime-pozzolan varied in consistency from almost that of the sample with no additive to two samples which each contained only two failure planes. The latter two samples bore no weakening from the water.

The freeze-thaw equipment performed satisfactorily but a few minor changes would improve its effectiveness. One suggested change would be to fasten the lid down firmly and not rely on the weight of the overlying box. This would more effectively seal out the cold by preventing its entrance into the box between the lid and the rubber gasket. One uncertainty that should be remedied is determination whether or not the samples are completely frozen. A thermistor placed centrally in a sample should suffice.

CHAPTER VII

DISCUSSION OF RESULTS

It was felt that an individual discussion of each graphical plot or tabular result, would cause some repetition and cross-reference, but that it would be the most effective method of presentation. In the following pages each separate plot is meant as a plank from which the platform of conclusions will be built. Before the presentation of the graphical data, a very brief summary of the expected error in the data is given, thereby providing a more intelligent assessment of the graphical data.

I ESTIMATE OF MAXIMUM PROBABLE ERROR

Appendix D contains the actual numerics but the intention here is to provide an estimate of the reliability of results. A summary of these based upon a unit volume indicates that the:

(1) density varied by ± 1.5%;

(2) volume of lime and of pozzolan each varied up to ± 2%;

(3) volume of soil varied by ± 3%;

(4) volume of water varied by ± 5% when computed from the dry density;

(5) volume of solids varied by ± 2.5%;

(6) additive-filled-voids on a volume basis varied by ± 4.5%.

All the foregoing percentages are based upon one hundred percent and in no case indicate the actual quantitive variation in an answer.

For an estimate of the accuracy of the strength determinations the standard deviation approach indicated a coefficent of variation in the order of five percent meaning less than 30 p.s.i. variance from the mean. For Portland Cement concrete where this method appears to be more widely used, this is termed as an order of very good results.

II FIGURE 17

PLASTIC LIMIT v.s. PERCENT LIME ADDITIVE

Originally the plot was used to determine the "lime fixation capacity", for estimating the minimum lime additive required for a permanent strength increase. The

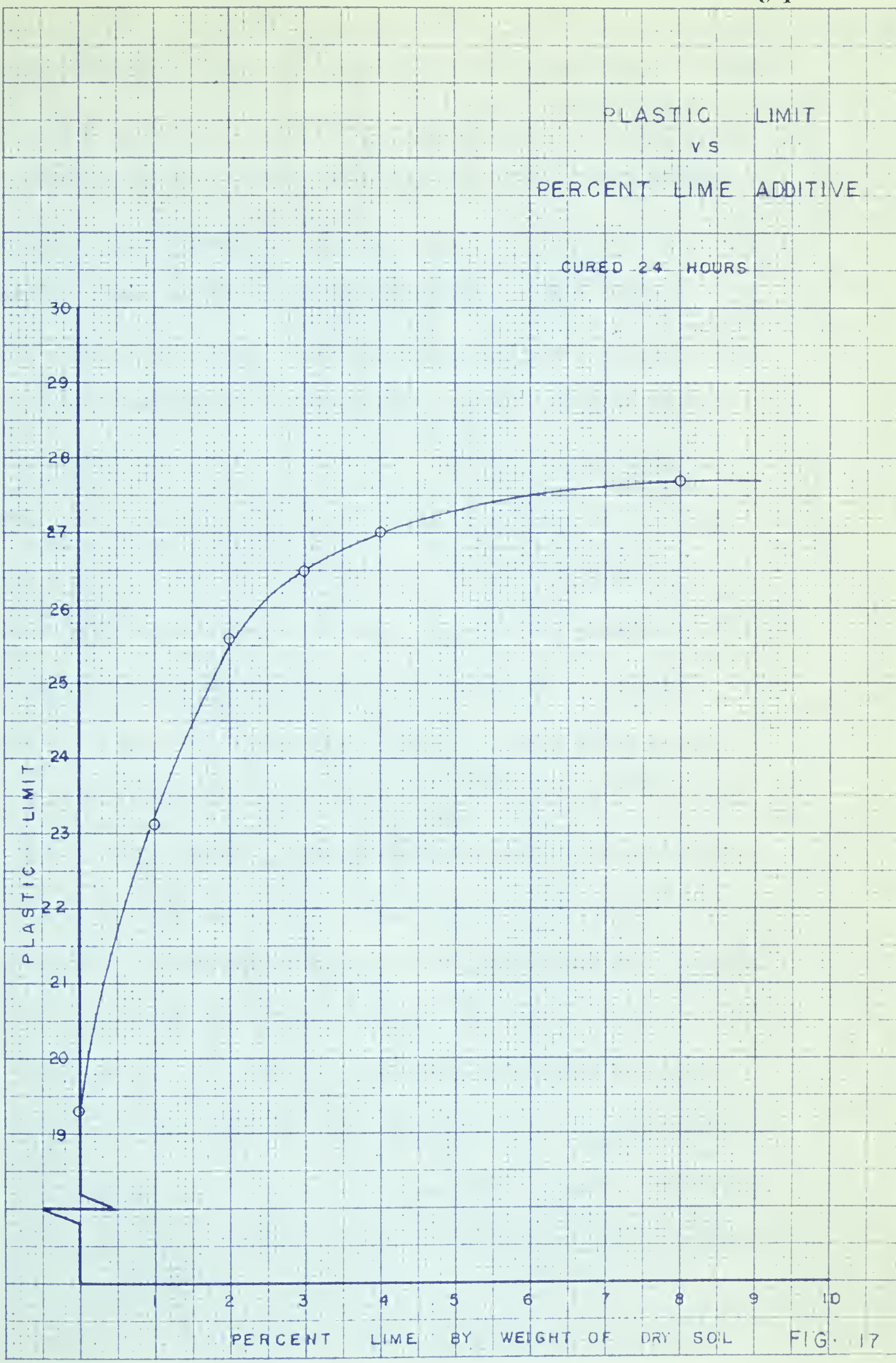

PLASTIC LIMIT
VS
PERCENT LIME ADDITIVE
CURED 24 HOURS
PLASTIC LIMIT
30
29
28
27
26
25
24
23
22
21
20
19
1
2
3
4
5
6
7
8
9
10
PERCENT LIME BY WEIGHT OF DRY SOIL

FIG. 17

minimum allowable lime content was taken as three percent of the dry weight of soil only, but during fabrication of lime-pozzolan-soil samples, the percent of each additive was based upon total dry weight of all components. The difference was small at three percent. The "lime fixation capacity" was confirmed by the twenty-eight day strength of samples with only lime added as per figure 21. It was felt that the soil did not contain much pozzolanic material so that the strength could be presumed to be largely due to modifying action (the samples were sealed air tight during the twenty-eight day curing period, therefors minimizing carbonation of lime and the resulting strength increase). Harvey, (1960), found that this modifying effect was dependent upon time; with the plastic limit decreasing below 4.7% of lime by dry weight of soil (for CI material) and increasing above this amount, as curing time progressed. Harvey's results provided a "lime fixation capacity" of three percent after one day of curing time. It could well be that this second optimum point of 4.7% was that amount of lime required for crystal growth to occur, with its more water resistant bonds. All that was apparent from figures 17 and 21 was that a modifying

action occurred in which the plastic limit was increased about fifty percent. There appears to be a trend, from data of others, indicating that the increase in plastic limit caused by the addition of lime to a soil, can be predetermined by using a unique percentage of the plastic limit of the soil alone.

III FIGURE 18

GRAPHICAL INTERPOLATION OF OPTIMUM STRENGTH-MOISTURE RELATIONS

Originally this was used to determine the optimum moisture-density relationship with various amounts of the two additives. While the relation was not truly a straight line interpolation, it did suffice and simplified the testing program. While the decrease in optimum percent moisture was expected with increasing compactive effort, a second variation was noticed. As the compactive energy increased, the optimum moisture percentage decreased at a faster rate for the lime only than for the pozzolan only, indicating a breakdown of a soil structure originally created by the lime.

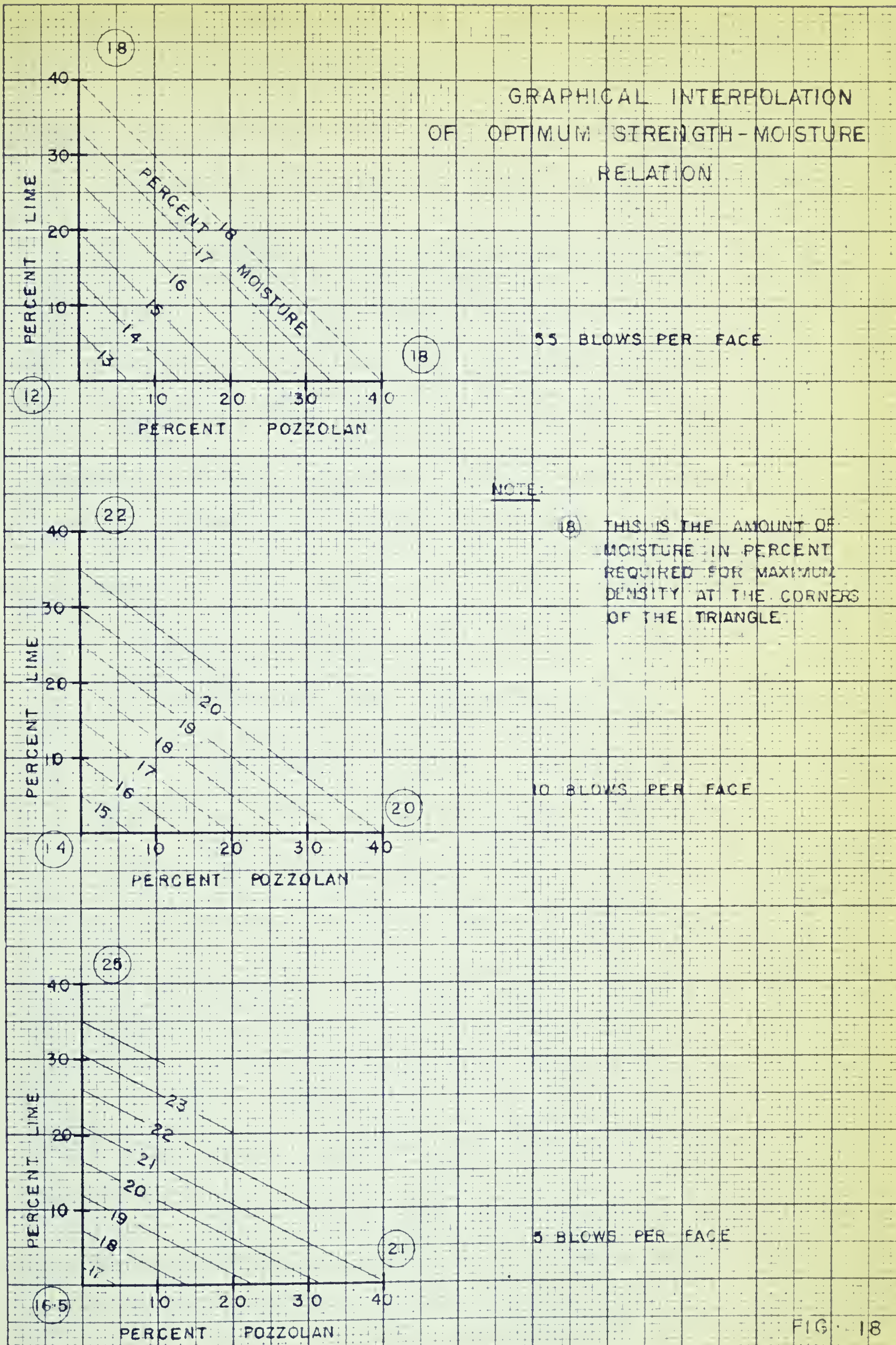

GRAPHICAL INTERPOLATION
OF OPTIMUM STRENGTH-MOISTURE
RELATION
55 BLOWS PER FACE
PERCENT MOISTURE
PERCENT LIME
PERCENT POZZOLAN
NOTE:
(18) THIS IS THE AMOUNT OF MOISTURE IN PERCENT REQUIRED FOR MAXIMUM DENSITY AT THE CORNERS OF THE TRIANGLE
10 BLOWS PER FACE
5 BLOWS PER FACE

FIG. 18

IV FIGURE 19

SOAKED UNCONFINED COMPRESSIVE STRENGTH v.s. PERCENT TOTAL ADDITIVE

This plot indicates the relative strengths at twenty-eight days for varying additive percents, four different ratios of lime to pozzolan, and three different compactive efforts. These compactive efforts approximate standard proctor, modified proctor, and an intermediate density. The letters at the end of each curve only indicate the identification for the last point of that particular ratio. For further information about samples refer to figure 23 at any one particular ratio. For the ratio 1:9 the minimum additive for permanent strength allowed only two samples to be tested, therefore, making only a limited prediction of strength increase possible in this area. These two points of the limited knowledge were connected with a straight line because the general overall trend appears to be that the greater the amount of additive, the larger the compressive strength. Only one point (on the 5:5 ratio) was taken at six percent total additive, because at those small additive amounts, extreme care must be taken with mixing of additives otherwise inadequate dispersion will

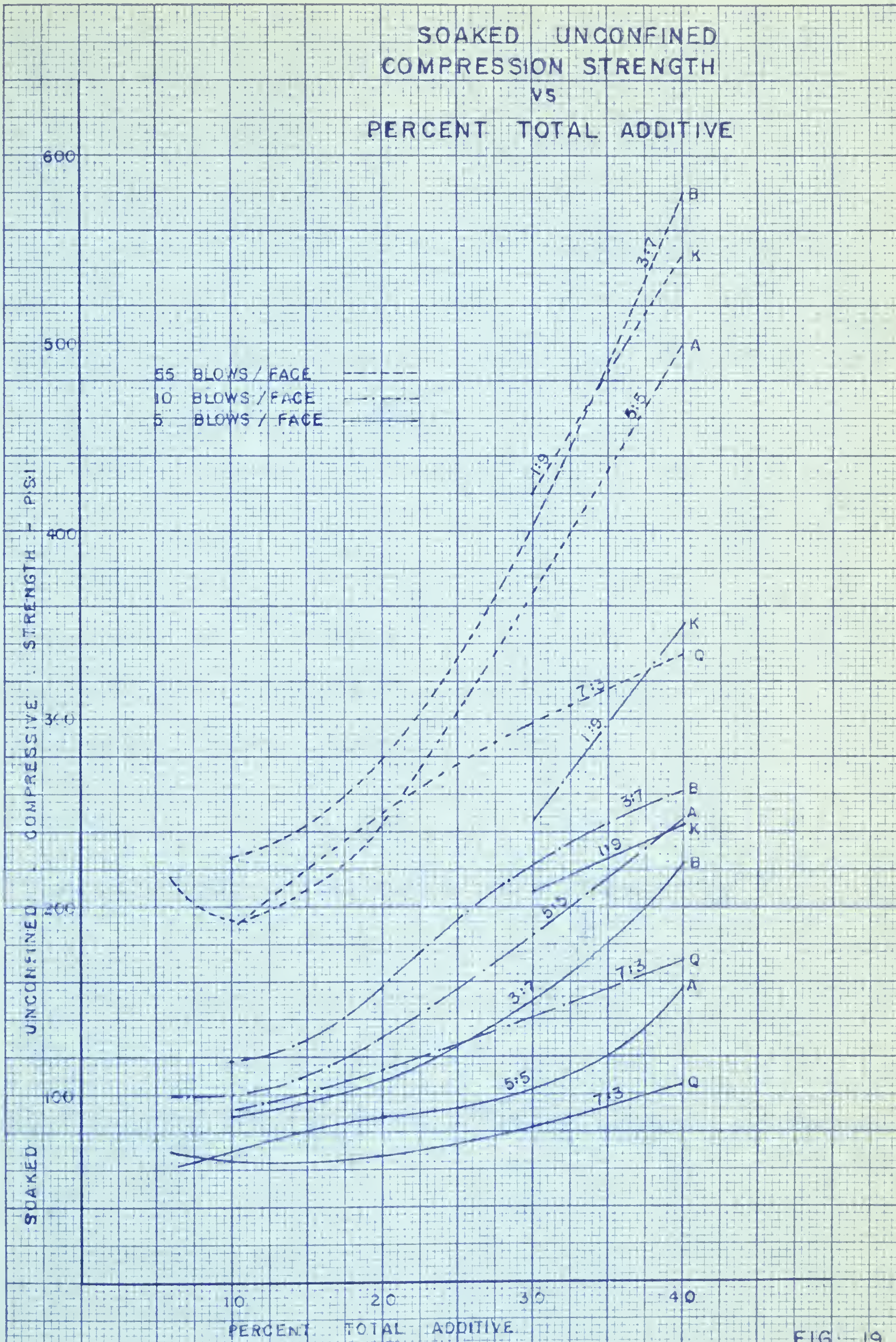

SOAKED UNCONFINED
COMPRESSION STRENGTH
VS
PERCENT TOTAL ADDITIVE
55 BLOWS / FACE
10 BLOWS / FACE
5 BLOWS / FACE
SOAKED UNCONFINED COMPRESSIVE STRENGTH - P.S.I
PERCENT TOTAL ADDITIVE
600
500
400
300
200
100
10
20
30
40
B
K
A
Q
3:7
1:9
5:5
7:3

FIG. 19

cause erratic results. At the commencement of the test, the use of extra data points in this area appeared unnecessary, therefore the upward trend of strength at low additive contents can not be checked. It appears that for practical purposes this strength increase is of a minor amount. While an attempt was made to maintain the density increase at equal increments, this as indicated in the following figure 20, was not successful, thereby permitting only a trend to be predicted from this curve. The trend indicates that increasing the compactive effort from Standard to Modified Proctor is more effective than increasing the additive content by twenty percent of the <u>total</u> <u>mix</u>, if compressive strength is used as a reference.

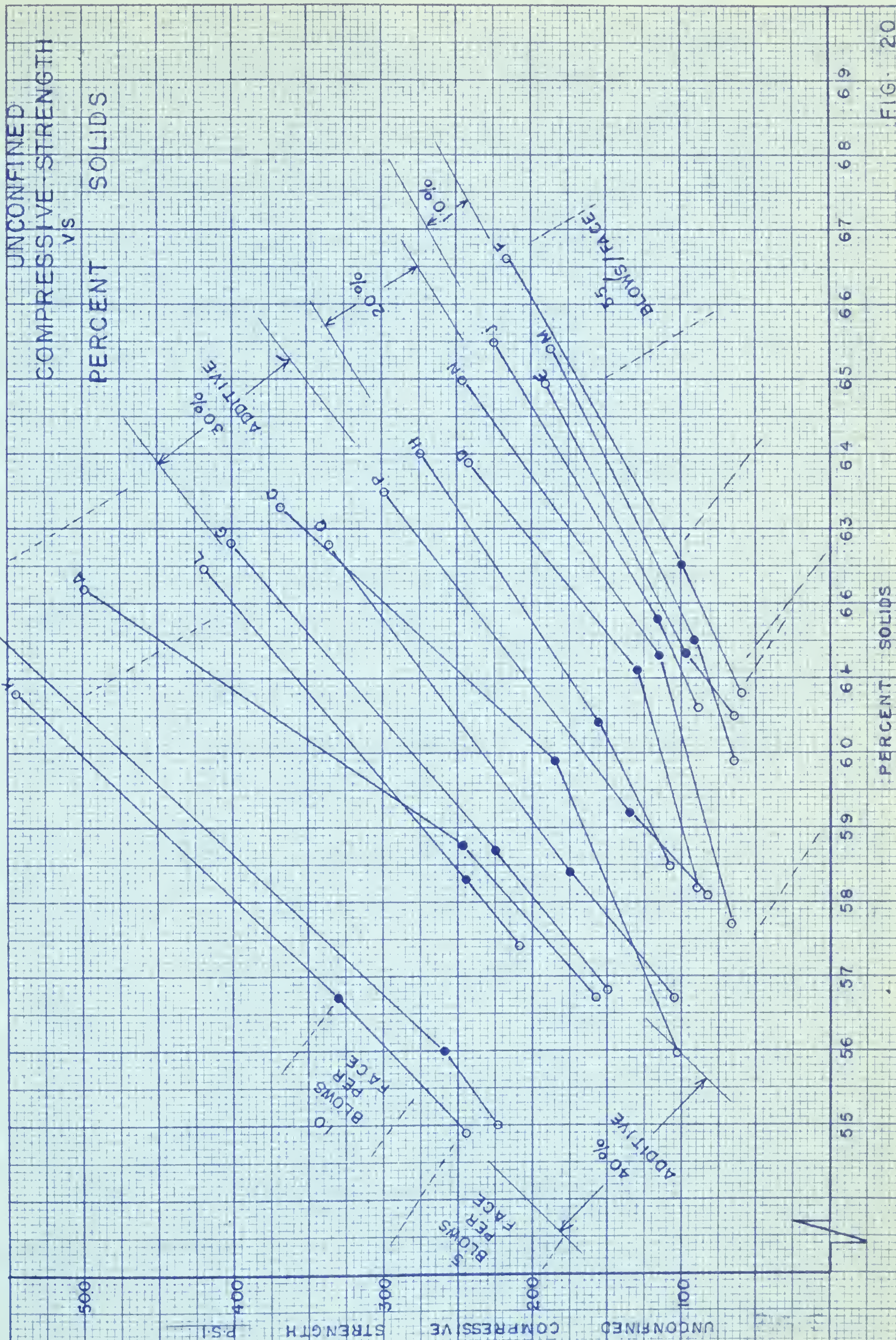
V FIGURE 20

UNCONFINED COMPRESSIVE STRENGTH

v.s. PERCENT SOLIDS

This graphical plot was an attempt to confirm or disprove the relationship put forward by one group of investigators[1], where a unique line was postulated.

1 Viskochil, Handy and Davids (1957), "Effect of Density on Strength of Lime-Flyash Stabilized Soil", pp. 11-13 H.R.B. Bull. No. 183.



UNCONFINED
COMPRESSIVE STRENGTH
VS
PERCENT SOLIDS
UNCONFINED COMPRESSIVE STRENGTH P.S.I.
100
200
300
400
500
PERCENT SOLIDS
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
10%
20%
30% ADDITIVE
40% ADDITIVE
5 BLOWS PER FACE
10 BLOWS PER FACE
65 BLOWS / FACE

FIG. 20

With the material used herein the above mentioned investigators were correct only in the fact that one percentage of additive at varying ratios will produce a "band" of points. The location within the band depends on the ratio of lime to pozzolan. The letter at the end of each line encodes the ratio. This graph shows that for the limits imposed the strength increase occurs as follows:

(1) The soaked unconfined strength increases as the total additive increases.

(2) For each additive amount the strength increase varies directly as the amount of pozzolan present.

(3) Increasing from Standard to Modified Proctor compaction tends to increase the strength by a relatively constant percentage of that at Standard Proctor (200 to 300% in this case) regardless of ratio or total additive.

(4) The larger the amount of additive the greater the effect of lime-pozzolan ratio on strength.

Also there is a trend indicating that the greater the amount of additive at one compactive effort, the larger

the amount of voids. This indicates a one-grain size structure is being approached. This relation is not linear as indicated but is probably similiar to a hyperbolic function and is limited at one end by the percent solids for the natural soil. Here the percent solids for the soil with no additive were 63.9, 68.5, and 71.3 for the three compactive efforts in order of increasing energy. One other obvious relation shown, was the true increase in density, or percent solids as was used here, with what was thought here to be equal increases in effective compactive energy. These equal increases were desirable only from the point of view of better defining the trend of each line by equal spacing of data points.

VI FIGURE 21 - UNCONFINED COMPRESSIVE STRENGTH WITH LIME ALONE

This relation has been discussed partially with reference to the "lime fixation capacity" in figure 17. This figure was used to approximate the modified strength needed to separate the cementation effect from the modifying action, the assumption being that little or no cementing would occur without pozzolan. In actual testing, samples

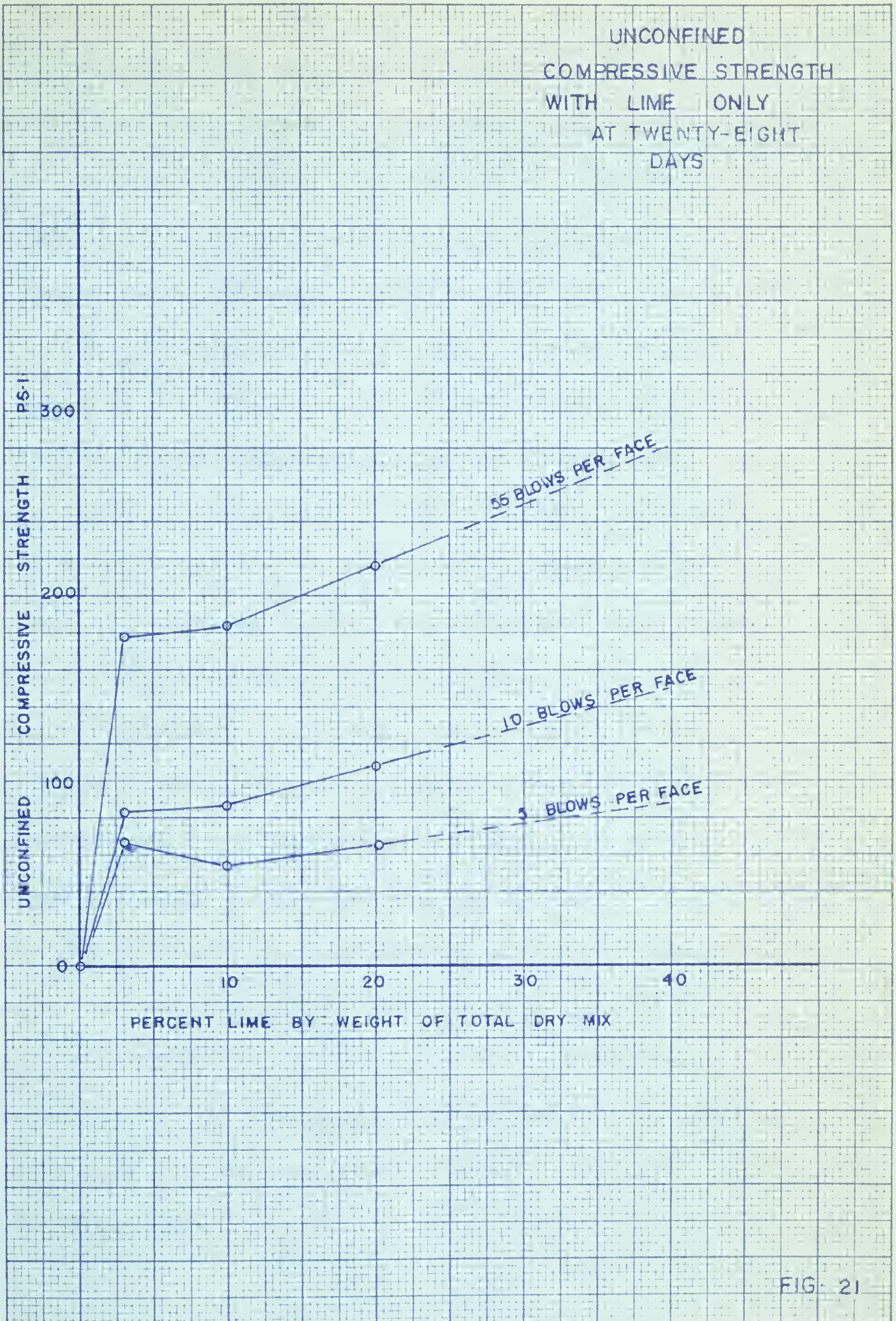

UNCONFINED
COMPRESSIVE STRENGTH
WITH LIME ONLY
AT TWENTY-EIGHT
DAYS
UNCONFINED COMPRESSIVE STRENGTH PSI
300
200
100
0
10
20
30
40
35 BLOWS PER FACE
10 BLOWS PER FACE
5 BLOWS PER FACE
PERCENT LIME BY WEIGHT OF TOTAL DRY MIX

FIG. 21

containing pozzolan and lime additives would be tested twenty-four hours (soaking period) after being manufactured to determine the modifying action strength. This item was not forseen in the actual testing program, therefore, this close approximation was used. The natural soil without lime additive was reduced to mud within two hours after being placed in the soaking bath, so the unconfined compressive strength of natural soil was set at zero. The "sag" in the curves at about ten percent lime may be the point of change-over from a decreasing modifying action to an increasing crystalline bonding although there is no basis for this theory other than personal opinion. The effect of increased compaction with lime additive alone is clearly shown where a four and one-half fold increase of the <u>effective</u> compaction energy caused a tripling of the unconfined strength. Now whether the greater densification increases the interlocking effect or utilizes the increased negative pore pressure to increase interparticle friction or whether some other item causes this strength difference, is not known. Only it is known that increased densification is beneficial to the short term soaked strength for a CI type of material.

VII FIGURE 22 - CEMENTATION STRENGTH v.s. ADDITIVE-FILLED-VOIDS

Here the "cementation" strength is the difference between the total soaked twenty-eight day unconfined strength and that "modified" unconfined strength obtained from figure 21. The attempt was here made to isolate the strength increase due to cementing action alone, and hoping that this might provide a unique relation. While no unique relation appeared the trends were of interest. The points plotted were those appearing in figure 23 with the highest additive amounts producing the highest additive-filled-voids; then decreasing in a direct relationship. For the twenty-eight day curing period, the lowest lime content at one additive percentage with the greatest densification, produced the highest cementation strength. While this relation is not expected to change for curing periods (at normal curing temperatures) of less than twenty-eight days, it could alter the highest strengths to a slightly larger percentage of lime per each additive amount at periods in excess of twenty-eight days. Also evident was the item that at one additive percent and one compactive effort, the strength increased as the pozzolan content

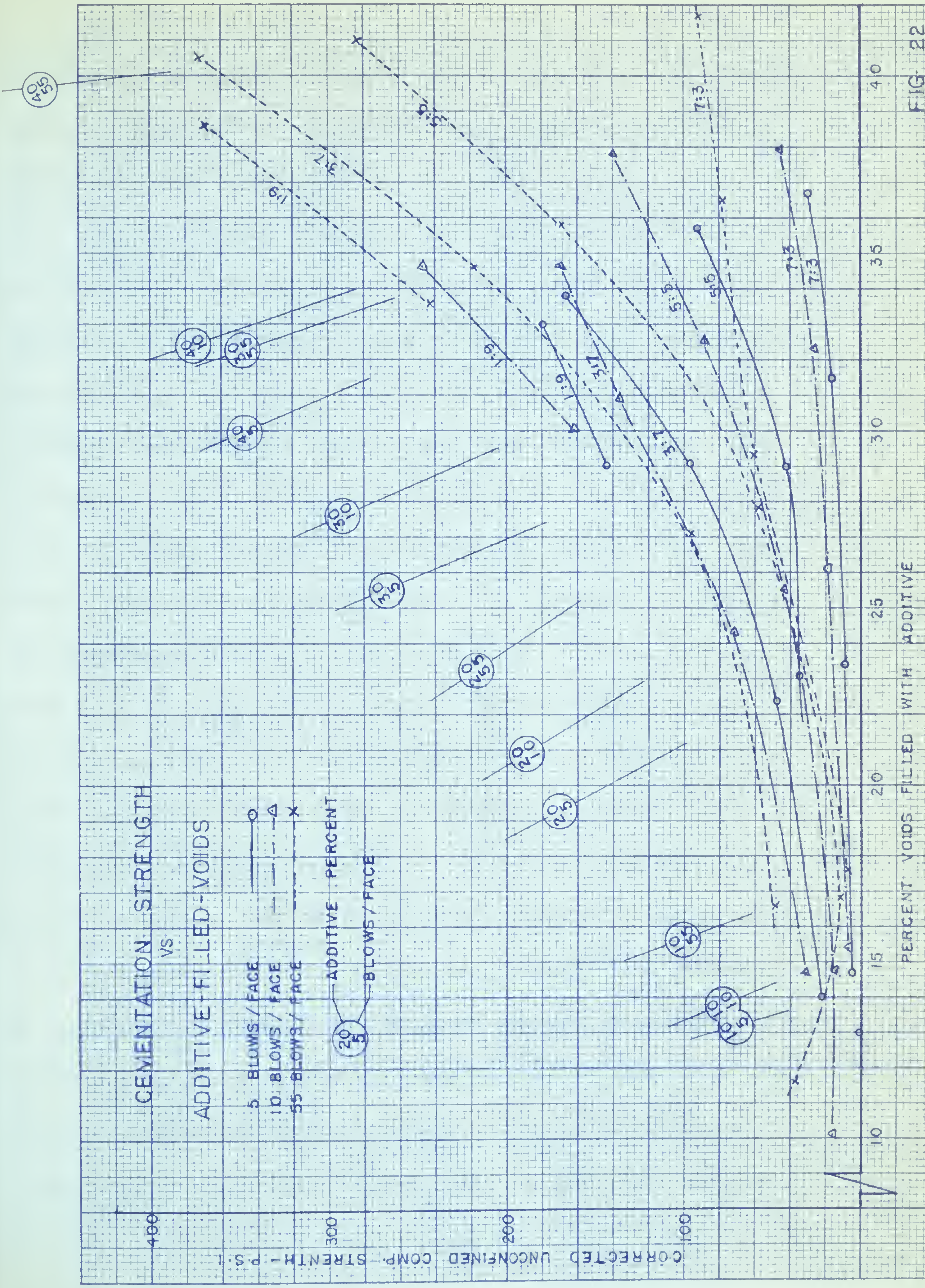

CEMENTATION STRENGTH
VS
ADDITIVE-FILLED-VOIDS
5 BLOWS/FACE
10 BLOWS/FACE
55 BLOWS/FACE
ADDITIVE PERCENT
BLOWS/FACE
PERCENT VOIDS FILLED WITH ADDITIVE
CORRECTED UNCONFINED COMP. STRENTH - P.S.I.
10
15
20
25
30
35
40
100
200
300
400

FIG. 22

increased and percent additive-filled-voids decreased. This indicated that at the lower lime amount the structure contained more voids but was stronger.

It is felt that the resistance to freeze-thaw could be predicted on the basis of these cementation strength curves by assuming a lower limiting strength value at say 250 p.s.i. The reason for selecting cementation rather than total strength is the opinion that only the former resists the strength loss due to freeze-thaw.

Allowing for the scatter of results, the curves plotted appeared to be exponential in the range considered and approached a lower asymptote of no strength at no additive. On the basis of this it is felt that similar curves could be developed for any soil with a minimum of twenty-four samples. After selecting a optimum ratio (probably between 1:9 and 3:7) of lime to pozzolan, six samples each at two differing compactive efforts at a total additive of say thirty percent would be constructed. A representative one-half would be broken immediately after twenty-four hours of total immersion in water, while the second representitive half of the group would be cured for twenty-eight days then soaked and tested. The same would

be repeated at a total additive content of twenty percent. The cementing strength of natural soil is assumed to be zero. Knowing three points on each exponential curve the strength relations could be drawn. The existing data could be used to formulate such design curves for the three components tested in this thesis. Though not obvious on the existing plot, each unique point (same ratio and additive) can be joined with a straight line including all three. The same plot as figure 22, on full logarithmic paper provides a similar shape, yielding no further information, but definitely lining each unique point at three densities in one straight line.

Though the design procedure suggested is empirical, this method or some similar one will have to be used until the effects of the change in each of the three variables on strength can be predicted from simple and quick tests.

The additive-filled-voids were determined on a volume basis. One cubic foot was used as the total volume with the total weight of other components determined from the dry density. The volume of the lime plus pozzolan, over the total volume of one cubic foot minus volume of

soil solids, provided the figure shown under the above title.

The following plots are meant as a general presentation of data rather than of any one particular relationship. In all these four following graphs the percent is by weight of total mix (i.e. soil + lime + pozzolan).

VII FIGURE 23

SAMPLE IDENTIFICATION CHART

This is a simplified three component chart where the third component is soil and though not shown exists to provide a total of one hundred percent. The various ratios are delineated by straight lines, while the constant total additives at any ratio, are also indicated by straight contour lines. Though not indicated, a lower limit of three percent lime by weight of total mix, exists for this investigation.

IX FIGURES 24, 25, 26 - STRENGTH CONTOURS AT THREE COMPACTIVE EFFORTS

These curves were interpolated from data points located as per figure 23. The bottom extremities are probably extended to the right in the region of two to three percent lime, but lacking definite information these

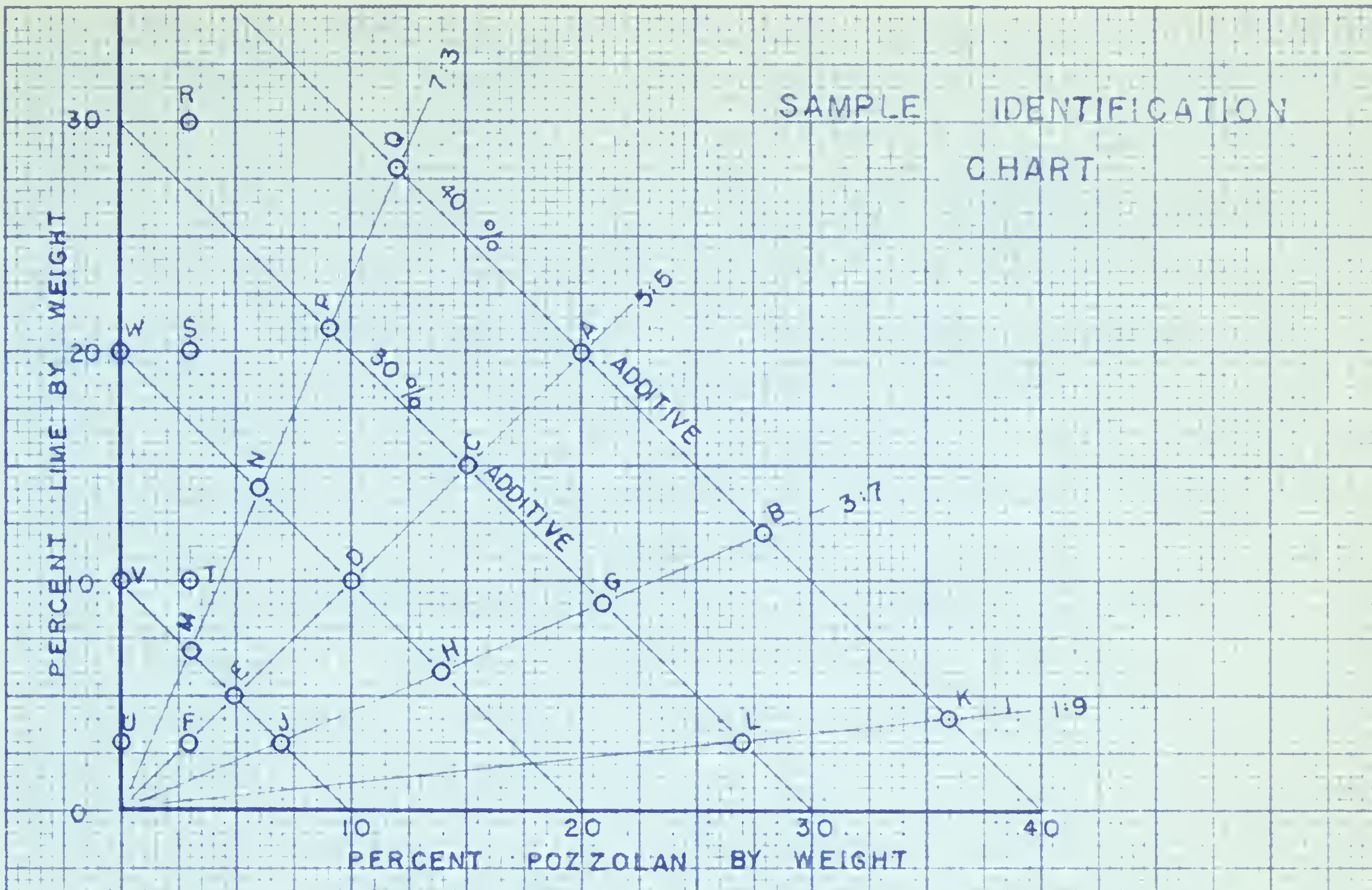

SAMPLE IDENTIFICATION
CHART
PERCENT LIME BY WEIGHT
PERCENT POZZOLAN BY WEIGHT
40 %
ADDITIVE
30 %
ADDITIVE
7:3
5:5
3:7
1:9
0
10
20
30
40
R
S
W
T
V
Q
P
A
N
C
B
D
G
H
M
E
F
J
U
L
K

FIG. 23

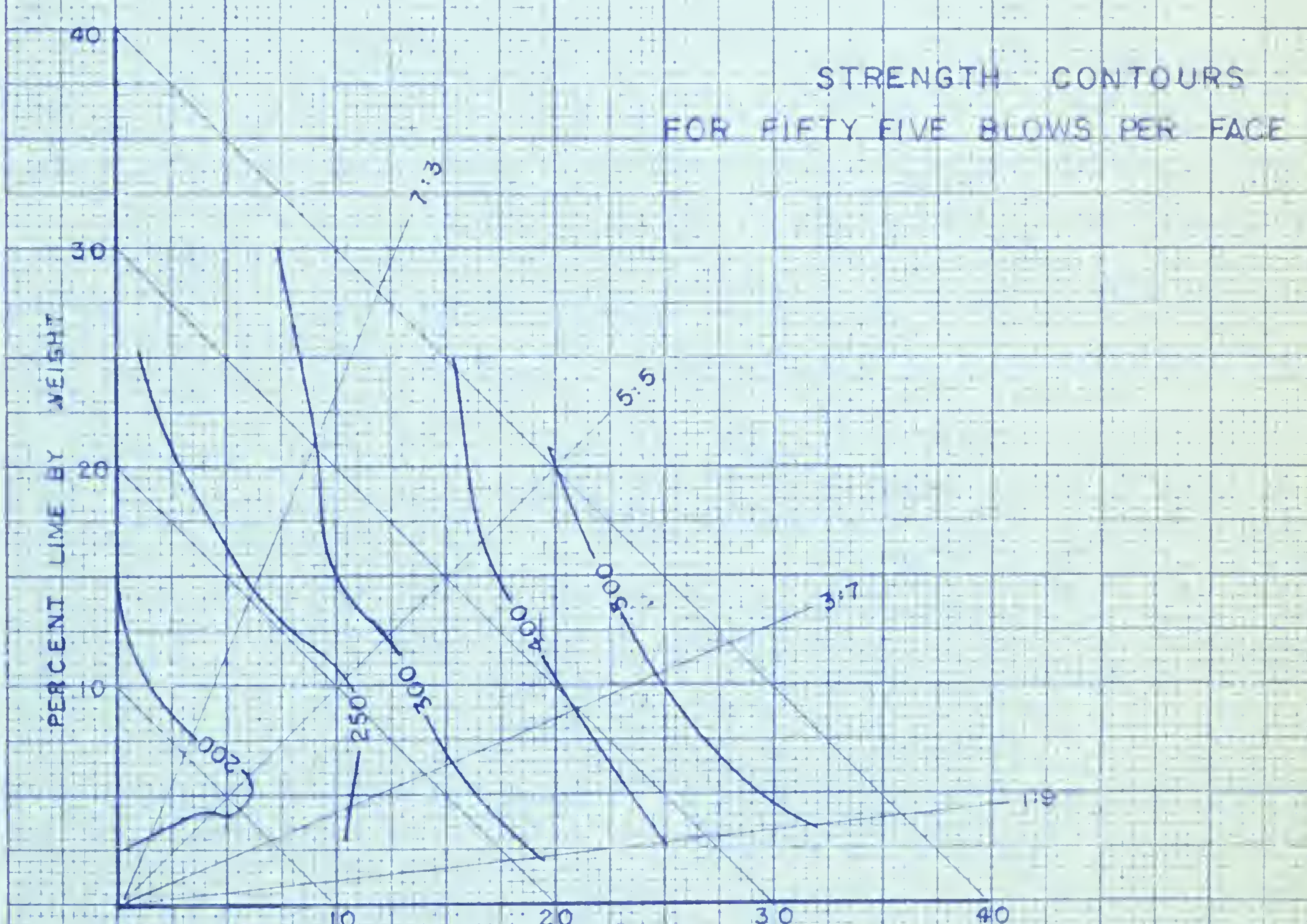

STRENGTH CONTOURS
FOR FIFTY FIVE BLOWS PER FACE
PERCENT LIME BY WEIGHT
PER CENT POZZOLAN BY WEIGHT
7:3
5:5
3:7
1:9
200
250
300
400
500
10
20
30
40

FIG. 24

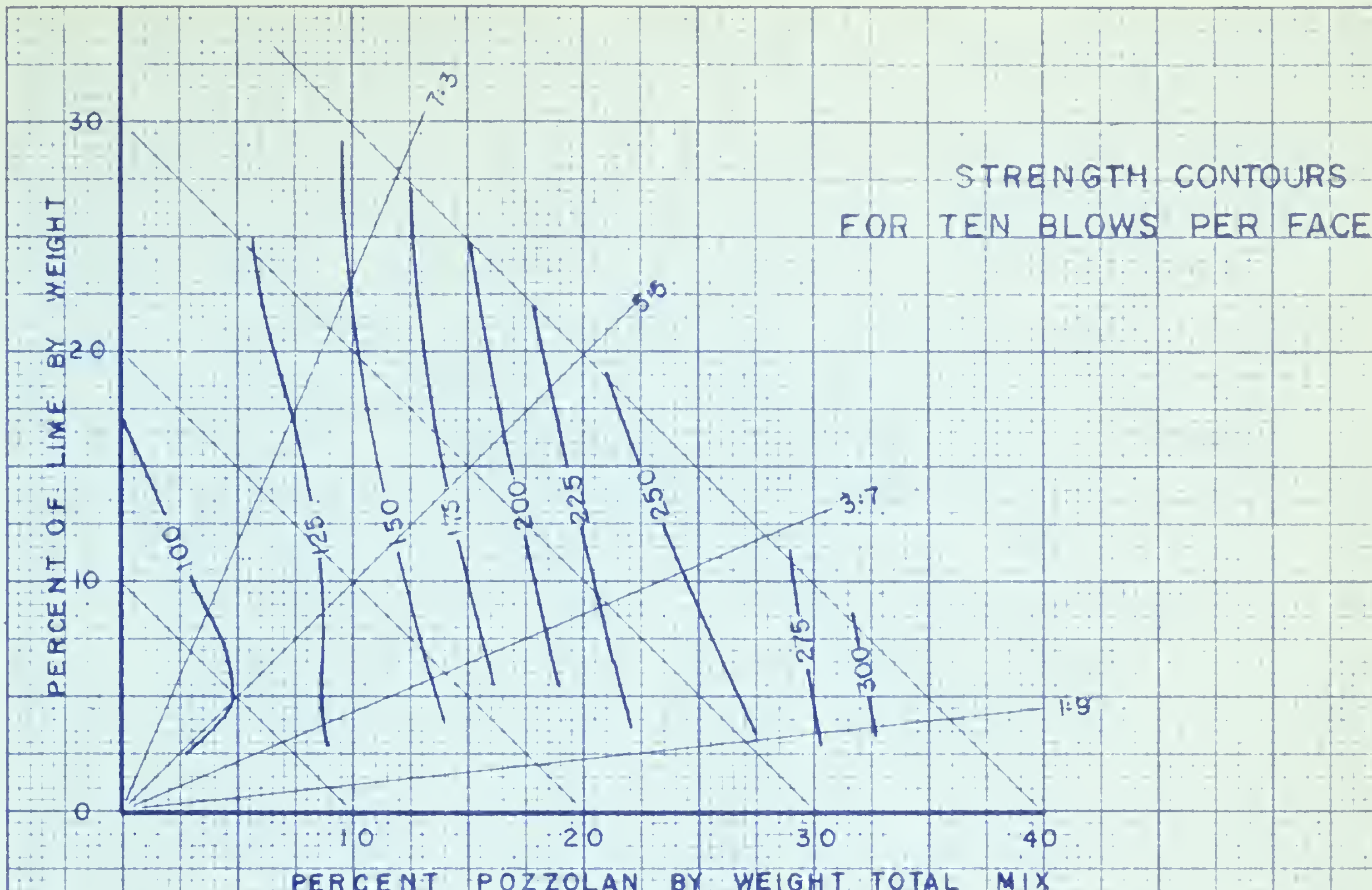

STRENGTH CONTOURS
FOR TEN BLOWS PER FACE
PERCENT OF LIME BY WEIGHT
PERCENT POZZOLAN BY WEIGHT TOTAL MIX
0
10
20
30
40
7:3
5:5
3:7
1:9
100
125
150
175
200
225
250
275
300

FIG. 25

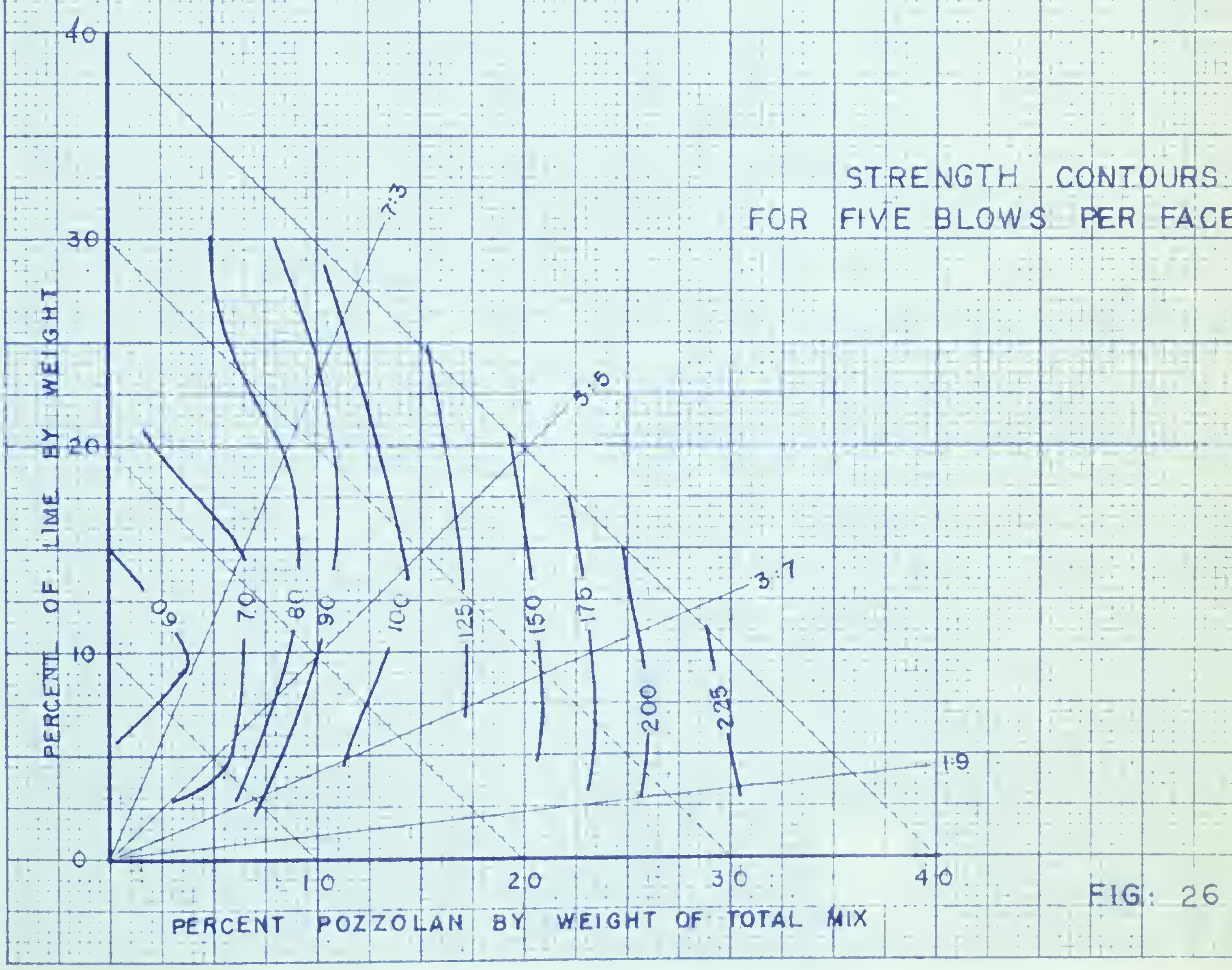

STRENGTH CONTOURS
FOR FIVE BLOWS PER FACE
PERCENT OF LIME BY WEIGHT
PERCENT POZZOLAN BY WEIGHT OF TOTAL MIX
0
10
20
30
40
7:3
5:5
3:7
1:9
60
70
80
90
100
125
150
175
200
225

FIG. 26

TABLE IV

SUMMARY OF TEST RESULTS

STANDARD PROCTOR COMPACTIVE EFFORT

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Series 5	Dry Density p.c.f	Percent Lime	Wt. Lime lb.	Percent Pozzolan	Wt. Pozzolan lb.	Percent Soil	Wt. Soil lb.	Percent Molding Water	Wt Water lb.	Vol. Lime c.f.	Vol. Pozzolan c.f.	Vol. L + P 11 + 12	Vol. Soil c.f.	Vol. Water c.f.	Vol. Solids c.f.	Water Cement Ratio 15/13	Vol. Total Voids 1 − Soil	Additive Filled Voids 13/18	Unconf. Compress. Strength p.s.i.	Modified Strength p.s.i.	Cementation Strength p.s.i.
A	92·9	20	18·6	20	18·6	60	55·7	23·2	21·6	·132	·109	·241	·326	·346	·567	1·44	·674	·357	159	66	93
B	91·6	12	11·0	28	25·6	60	55·0	21·3	19·5	·079	·150	·229	·321	·312	·550	1·36	·679	·338	223	56	167
C	92·7	15	13·9	15	13·9	70	64·9	19·4	18·0	·099	·081	·180	·379	·288	·559	1·60	·621	·290	·102	60	42
D	97·7	10	9·8	10	9·8	80	78·1	18·4	18·0	·069	·057	·126	·456	·288	·582	2·29	·544	·232	89	54	35
E	100·7	5	5·0	5	5·0	90	90·7	18·0	18·1	·036	·029	·065	·540	·290	·605	4·47	·460	·141	64	63	1
F	103·4	3	3·1	3	3·1	94	97·2	17·5	18·1	·022	·016	·040	·568	·290	·608	7·25	·432	·092	70	66	4
G	95·3	9	8·6	21	20·0	70	66·7	19·8	18·9	·061	·117	·178	·390	·303	·568	1·70	·610	·292	150	55	95
H	98·7	6	5·9	14	13·8	80	79·0	19·2	18·9	·042	·081	·123	·462	·303	·585	2·46	·538	·228	108	61	47
J	103·0	3	3·1	7	7·2	90	92·7	17·5	18·0	·022	·042	·064	·542	·288	·606	4·50	·458	·140	89	66	23
K	93·1	4	3·7	36	33·5	60	55·9	21·0	19·5	·120	·196	·222	·327	·315	·519	1·47	·673	·330	245	65	180
L	97·5	3	2·9	27	26·3	70	68·3	20·1	19·6	·021	·154	·175	·399	·314	·574	1·79	·601	·294	210	66	144
M	100·8	7	7·1	3	3·0	90	90·7	17·9	18·0	·051	·018	·069	·530	·288	·599	4·18	·470	·147	64	59	5
N	95·8	14	13·4	6	5·8	80	76·6	18·4	17·6	·095	·034	·129	·448	·282	·577	2·18	·552	·234	67	58	9
P	95·2	21	20·0	9	8·6	70	66·6	22·4	21·3	·142	·050	·192	·389	·342	·581	1·79	·611	·315	·83	66	17
Q	91·6	28	25·6	12	11·0	60	55·0	23·6	21·6	·182	·064	·246	·321	·346	·567	1·41	·671	·367	105	74	31
R	92·8	30	27·9	3	2·8	67	62·1	23·0	21·4	·199	·016	·215	·363	·343	·578	1·60	·637	·337	76	77	—
S	96·3	20	19·3	3	2·9	77	74·1	22·0	21·2	·137	·017	·154	·433	·340	·587	2·20	·567	·274	73	66	7
T	100·3	10	10·0	3	3·0	87	87·3	20·0	20·1	·071	·018	·089	·510	·322	·599	6·32	·490	·182	60	54	6
U	104·2	3	3·1	0	—	97	101·1	18·2	19·0	·022	—	·022	·591	·304	·613	13·80	·409	·054	67	66	—
V	101·4	10	10·1	0	—	90	91·3	19·1	19·4	·072	—	·072	·533	·311	·605	4·32	·467	·154	54	54	—
W	96·5	20	19·3	0	—	80	77·2	21·5	20·8	·137	—	·137	·452	·333	·589	2·43	·548	·250	64	66	—
X	109·3	0	0	0	—	100	109·3	18·0	19·7	—	—	—	·639	·316	·639	—	·361	—	32	—	—

parts were omitted. Even after twenty-eight days the permanence of the strength increase is dubious at the 1:9 ratio. For any one specific contour line the most desirable strength occurs where the line is closest to the lowest additive percent. For example in figure 24 the 300 p.s.i. line is nearest to the twenty percent additive line at a ratio between 1:9 and 3:7. For all three compactive efforts this occurs in the area below the 3:7 ratio. As the compactive effort decreases the use of more pozzolan as opposed to an increase of lime, is more useful in strength increase. Also at additives below fifteen percent there is a sudden minor increase of twenty-eight day strength. The interest lies in the reason for the occurrence rather than in the minor increase in strength. Though a similar effect was evident in figure 21 with lime alone, no explanation is apparent unless this is caused by crystal bonding. While this plot is an effective way to present a maximum of variables with a minimum of confusion, it required a major investigation the size of this one for comprehensive results.

CHAPTER VIII

CONCLUSIONS

1. The graphical plots of compressive strength versus some indicator of additive content do not provide a unique relation which is typical of all mixtures used. In fact for the CI soil used, a singular relation is obtained for only each blend and differing from blend to blend. These differences are not due to the probable error because of their non-random arrangement and also because the range of the probable computed error is smaller than this variation.

2. For the materials utilized (hydrated lime, Diamond City Shale and a CI soil) the optimum ratio of lime to pozzolan for maximum unconfined compressive stress occurs between 1:1 and 1:9; the latter limit being specified because of the unrealistic amount of lime required for permanent strength increases at larger ratios of say 1:10.

3. Increased compaction of any one blend is greatly beneficial to the twenty-eight day unconfined compressive strength of a CI material.
4. A water to "cement" ratio of 1:1 provides near optimum strengths for all blends tested. Here "cement" means lime plus pozzolan.
5. As the compaction increases the lime content becomes more important in unconfined compressive strength considerations for a CI material.
6. For the components tested the addition of lime to the soil greatly increases the resistance to deterioration by soaking in water. This is not so for the addition of pozzolan alone to the soil.
7. The mixing operation has a large effect on the final strength of the product particularly at low additive contents.
8. For this soil (CI), little or no swelling occurred over a twenty-four hour period at normal room temperatures.

9. For a particular compactive effort, using CI soil, lime and lime-pozzolan additives decrease the dry density but increase the unconfined compressive strength.

10. As indicated by a literature survey, the strength growth of soil-lime-pozzolan mixtures is influenced as much by very small amounts of chemical impurities as by the type of main chemical additives. This indicates that some one overall factor representing the soil "manufacturing process" such as sesquioxide ratio or Pedological Soil classification would be a more reasonable method of classifying the soil, at least for the purpose of this or similiar investigations.

CHAPTER IX

RECOMMENDATIONS

1. An economic study of the probability of utilizing lime-pozzolan admixtures in Canada, should be performed before further research is continued. Once it is shown to be economically feasible under assumed conditions, then these conditions should be aspired to.
2. The effects of the lime and pozzolan used in this investigation, upon other fine-grained soil types, should be studied. The same testing approach is recommended because of its wide coverage.
3. An investigation should be performed to determine if the addition of lime to a soil, decreases the soil's resistance to frost "lensing".
4. A heavier compaction hammer should be used for obtaining Above-Standard Proctor densities to minimize compaction time and mold perimeter friction.
5. The durability of lime-pozzolan-soil mixtures, to freeze-thaw and wet-dry cycles, should be determined.

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APPENDICES

APPENDIX A

MODIFIED BRITISH FREEZE-THAW TEST

APPENDIX A

Modified British (B.S. 1924-1957) Freese-Thaw Test As Used by Iowa Engineering Experiment Station, Iowa State University of Science and Technology, Ames, Iowa

Scope

1. This method covers the determination of the change in the unconfined compressive strength of 2 inch diameter specimens of stabilized fine grained soil when subjected to cycles of freezing and thawing under specified conditions. The test specimens are prepared as described under Methods or Preparing and Testing Specimens in this paper or as described in the Portland Cement Association's Soil-Cement Laboratory Handbook (14, p. 32).

Apparatus

2. The apparatus required (Figure 6) is as follows:

   a. A commercial vacumm flash having a neck with an internal diameter approximately 21/2 inches and an internal depth of at least 4 inches.

b. A specimen holder of low thermal conductivity and resistant to deformation under the test conditions, and capable of supporting a stabilized soil specimen 2 inches high and 2 inches in diameter within the vacuum flask, so that the upper flat surface of the specimen is flush with the top of the flask (Figure 6). The base of the carrier shall be perforated in order to permit free access of water to the underside of the psecimen.

c. A refrigerated space within which is maintained a temperature of $-5 \pm 1°C$ ($23 \pm 2°F$), and which is large enough to contain the vacuum flask with its enclosed specimen. A thermometer mounted inside the refrigerated space.

d. A supply of asphalt or resin-base paint.

e. A supply of self-adhering membrane (the commercial product "Saran Wrap" was found very satisfactory).

f. About 100 ml of distilled water, cooled to $8 \pm 2°C$ ($46 \pm 4°F$).

Preparation of Specimens for Test

3. For each determination two identical specimens 2 ± 0.05 inches high and 2 inches in diameter shall be prepared. (If greater accuracy is desired four or six identical specimens may be prepared for each determination.)

Test Procedure

4. a. After the desired curing period any covering material on the specimens shall be removed and both specimens shall be weighed. The method and length of curing will depend on the method of stabilization. If either specimen has lost more than 2 g in weight during storage in a moist room maintained at a temperature of $21 \pm 1.78C$ ($70 \pm 30°F$) and a relative humidity of at least 90%, both specimens shall be discarded. If dry curing is used to reduce the volatile content of specimens to a desired percentage of the original volatile content, the difference in

weight between the specimens should not exceed 1 g.

b. After weighing, a coating of asphalt or resin-base paint, about 1 mm thick, shall be applied to the flat top surfaces of both specimens and be allowed to dry. The specimens shall then be immersed in distilled water at 25 ± 2°C (77 ± 4°F).

c. After immersion for twenty-four hours one of the specimens shall be removed from the water and dried with blotting paper. A collar, 1 1/2 inches deep, of a self-adhering membrane ("Saran Wrap") shall be placed around the top of the specimen.

d. Sufficient water at a temperature of 8°C (46°F) shall be poured into the vacuum flask so that when the specimen dealt with in c. above is inserted in the holder and the latter placed in the flask, the bottom 1/4 inch of the specimen is immersed in water. The vacuum flask and its contents shall then be placed in

the refrigerated space maintained at $-5 \pm 1°C$ ($23 \pm 2°F$) for a period of sixteen hours.

e. The flask and contents shall be removed and thawed for a period of eight hours at a temperature of $25 \pm 2°C$ ($77 \pm 4°F$). If, after thawing, the level of the water inside the vacuum flask has dropped so that it is no longer in contact with the base of the specimen, water at 8°C (46°F) shall be added to restore the level.

f. The procedure described in d. and e. above constitutes one cycle of freezing and thawing. Testing shall continue until the specimen has been subjected to 14 such cycles: the eight hour thawing period may be extended to sixty-six hours for a maximum of four cycles of the total 14 cycles if this is required for experimental convenience. [The number of cycles of freezing and thawing in the test should approximate the number of cycles that the stabilized soil will be subjected to in the

road each winter. Thus 14 cycles may not be appropriate in all climates or for all components (base, subbase, subgrade) of roads./

g. At the conclusion of the freezing and thawing cycles the thawed specimen shall be removed from the holder and, together with the second (control) specimen which has been stored in water during the entire period (15 days), shall be allowed to drain for 15 minutes. The heights of both specimens shall be measured.

h. The unconfined compressive strengths of the two specimens shall then be determined. Each specimen shall be placed centrally on the lower platen of the compression testing machine, and the load shall be applied to the ends of the specimen. The load shall be applied so that the rate of deformation is uniform and approximately 0.10 inch/minute. The maximum load in pounds exerted by the testing machine shall be noted and recorded

(p_f for the freeze-thaw specimen and p_c for the control specimen).

i. The moisture contents of representative samples of fragments taken from the interiors of the specimens shall be determined. In the case of soil stabilized with a fluid stabilizer, an additional representative sample of the fragments shall be set aside and their nonaqueous fluid stabilizer content(s) determined.

Calculations

5. a. The unconfined compressive strengths (p_f and p_c) of the two specimens shall be calculated from the formula:

$$p = 0.318\ P\ \text{(psi)}$$

where p = the maximum load recorded in pounds.

b. The index of the resistance to the effect of freezing (R_f) shall be calculated from the formula:

$$R_f = \frac{100 p_f\ (\%)}{p_c}$$

Reporting of Results

6. a. The values of p_c, p_f, and R_f, shall be reported, the latter to the nearest 5%. The report shall also include relevant details of the composition of the stabilized soil mixture, the dry density at time of molding, and the moisture content and linear dimensional charges of specimens.

APPENDIX B

COMPARISON OF COMPACTIVE ENERGIES FOR TWO MOLD SIZES

APPENDIX B

COMPARISON OF COMPACTIVE ENERGIES FOR TWO MOLD SIZES

1. Standard Proctor (4" dia. sample)

$$25 \frac{\text{blows}}{\text{layer}} \times 3 \text{ layers} \times 1 \text{ ft.} \times \frac{5.5 \text{ lb}}{\text{blow}} \times \frac{30}{\text{cu. ft.}}$$

$= 12375$ ft. lb./cu. ft.

2. Modified Proctor

$$25 \frac{\text{blows}}{\text{layer}} \times 5 \text{ layers} \times 1.5 \text{ ft.} \times \frac{10 \text{ lb.}}{\text{blow}} \times \frac{30}{\text{cu. ft.}}$$

$= 56250$ ft. lb./cu. ft.

3. Five Blow Miniature (2" x 2" cylindrical sample)

$$5 \frac{\text{blows}}{\text{face}} \times 2 \text{ faces} \times 1 \text{ ft.} \times \frac{5 \text{ lb.}}{\text{blow}} \times \frac{1728}{6.28 \text{ cu. ft.}}$$

$= 13750$ ft. lb./cu. ft.

4. Twenty-five Blow Miniature

$$\frac{25}{5} \times 13750 \text{ ft. lb./cu. ft.} = 68750 \text{ ft. lb./cu. ft.}$$

5. Fifty-five Blow Minature

$$\frac{55}{5} \times 13750 \text{ ft. lb./cu. ft.} = 151,250 \text{ ft. lb./cu. ft.}$$

6. Summary of Densities

Type of Compaction	Max. Dry Density	Compac. Energy ft. lb./cu. ft.
Modified Proctor	121.5 p.c.f.	56,250
Standard Proctor	110.5	12,375
55 Blows/Face	120.5	151,250
25 Blows/Face	119.0	68,750
10 Blows/Face	116.0	27,500
5 Blows/Face	110.5	13,750

APPENDIX C

SAMPLE AND PROBABLE ERROR COMPUTATIONS

APPENDIX C

SAMPLE AND PROBABLE ERROR COMPUTATIONS

The errors in the design computations for proportioning are the personal and equipment type for which there is no mathematical correction. This "scatter" is estimated by a statistical approach, even though this approach is not usually used with less than about thirty samples. Sample 5B is used as an example.

	Strength lbs.	Deviation	Deviation^2
	650	50	2500
	730	30	900
	710	10	100
	690	10	100
	670	30	900
	740	40	1600
Total	4190		6100
Average	700		1220
Square Root			35 lb.

i.e. for less than 30 tests divide deviation squared by n - 1

Therefore the strength is (700 + 35) lb. or a coeffcent of variation of five percent.

Sample 5A

$$\text{Dry Density, p.c.f.} = \frac{1.21 \times \text{Wet Weight gm.}}{(1 + \%\ \text{moisture})\ \text{Height inches}}$$

$$= \frac{1.21 \times 188.22 \pm 0.05\%}{(1 + 0.232)\ 1.982 \pm 1.4\%}$$

$$= 93.2 \text{ p.c.f.} \pm 1.5\%$$

Then using the average of six densities = 92.9 p.c.f.

$$\text{Weight of Lime per cubic foot} = \frac{92.9 \text{ lb.} \pm 1.5\%}{\text{cu. ft.}} \times \frac{20 \pm 0.5\%}{100\%}$$

$$= 18.6 \text{ p.c.f.} \pm 2.0\%$$

$$\text{Volume of Lime per cubic foot} = \frac{18.6 \text{ lb.}}{\text{cu. ft.}} \times \frac{1}{2.25 \times 62.4}$$

$$= 0.132 \text{ cu. ft.} \pm 2\%$$

Similarly the volume of the other constituents are:

Pozzolan = 0.109 cu. ft. per cu. ft. ± 2%

Soil = 0.326 cu. ft. per cu. ft. ± 3%

Water = 0.346 cu. ft. per cu. ft. ± 5%

Volume of solids = Volume pozzolan + lime + soil

= 0.567 cu. ft. per cu. ft. ± 2.5%

Additive-filled-voids = 0.357 ± 4.5%

= (35.7 ± 1.6)%

APPENDIX D

TEST DATA FOR MOISTURE-DENSITY RELATIONS OF VARIOUS LIME-POZZOLAN-SOIL MIXTURES

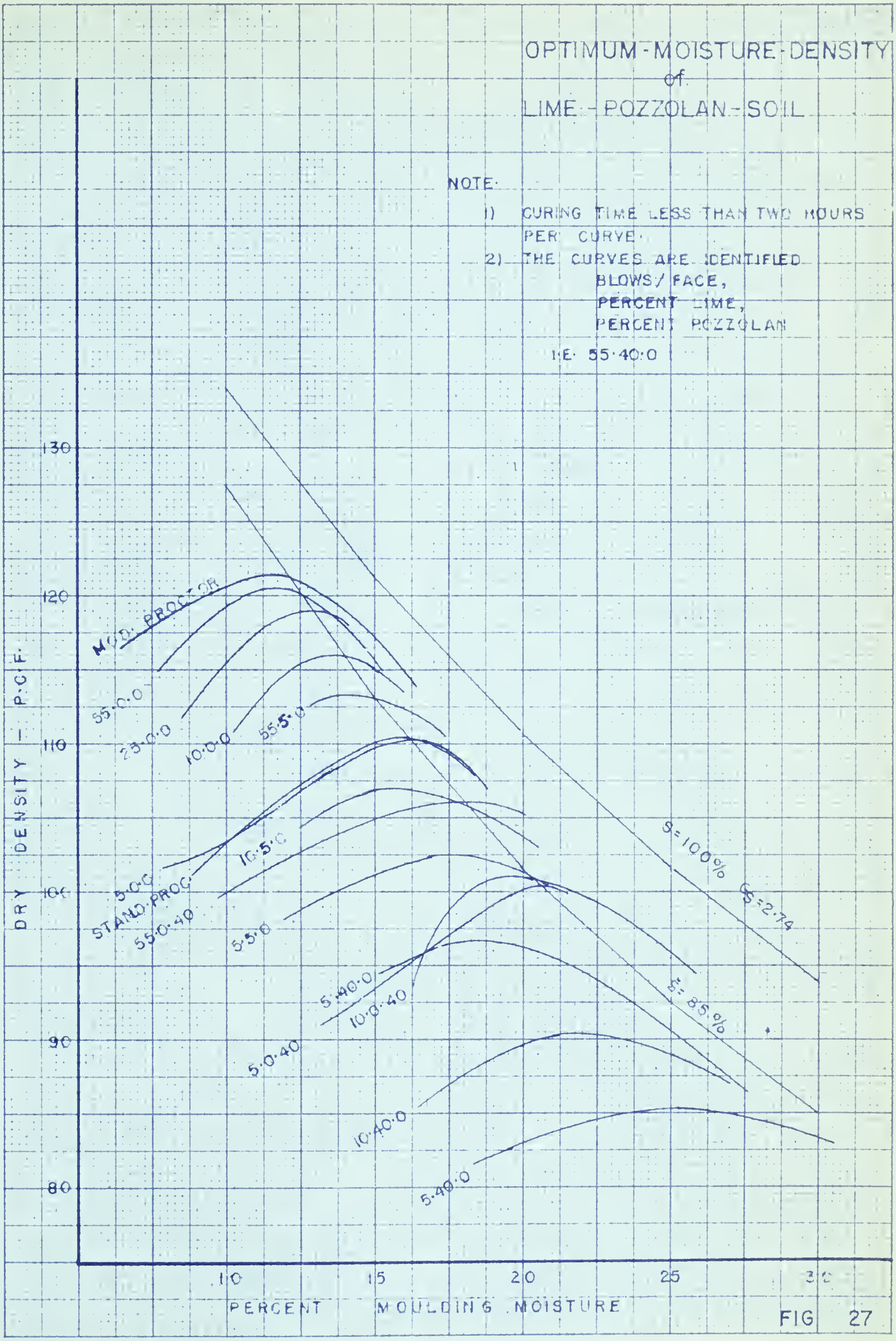
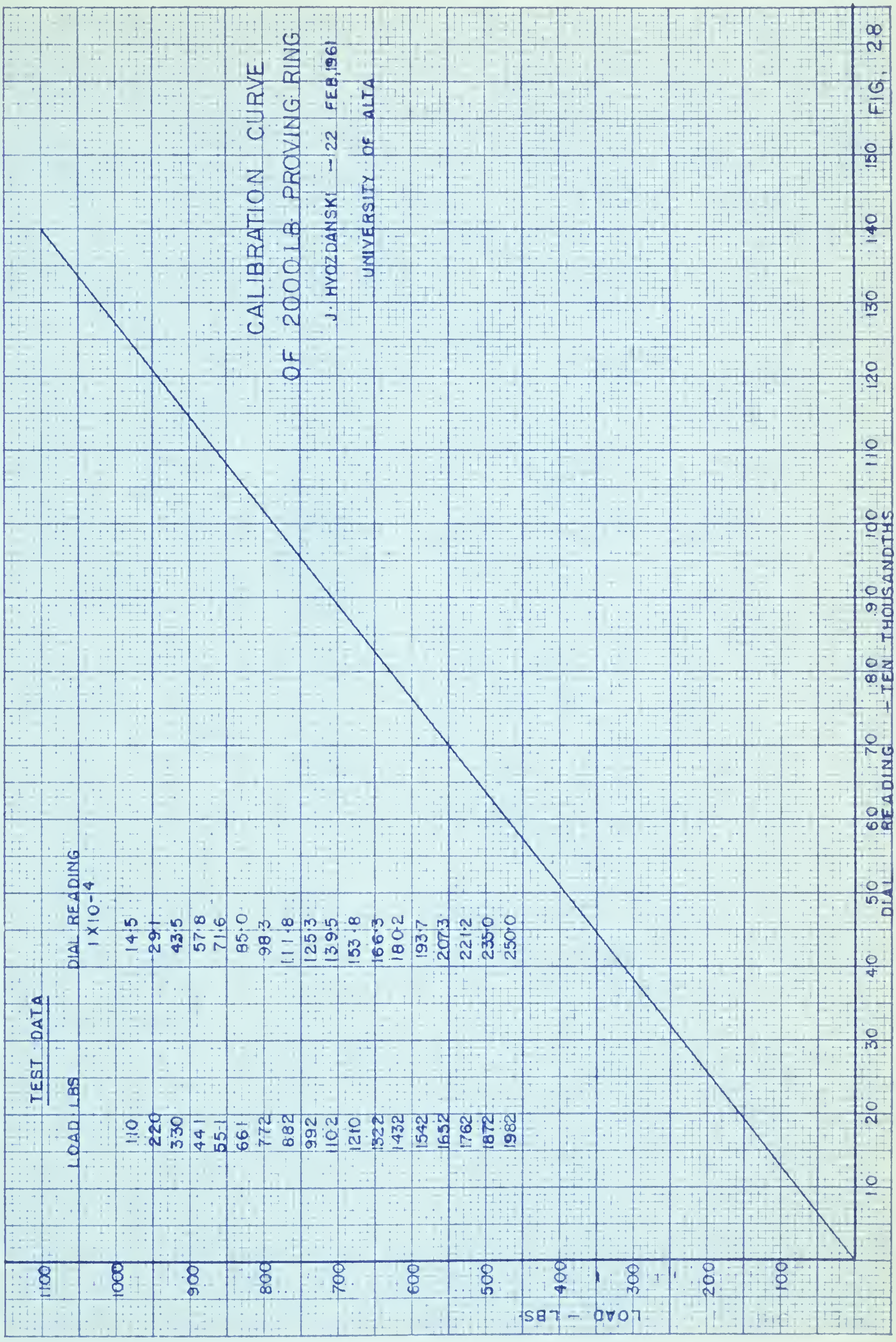

OPTIMUM-MOISTURE-DENSITY
of
LIME - POZZOLAN - SOIL
NOTE
1) CURING TIME LESS THAN TWO HOURS PER CURVE.
2) THE CURVES ARE IDENTIFIED BLOWS/FACE, PERCENT LIME, PERCENT POZZOLAN
I.E. 55·40·0
DRY DENSITY — P.C.F.
130
120
110
100
90
80
10
15
20
25
30
PERCENT MOULDING MOISTURE
MOD. PROCTOR
55·0·0
25·0·0
10·0·0
55·5·0
10·5·0
5·0·0
STAND. PROC
55·0·40
5·5·0
5·40·0
10·0·40
5·0·40
10·40·0
5·40·0
S=100%
G=2.74
S=85%

FIG 27


CALIBRATION CURVE
OF 2000 LB. PROVING RING
J. HVOZDANSKI — 22 FEB, 1961
UNIVERSITY OF ALTA
TEST DATA
LOAD LBS
DIAL READING
1 X 10-4
110 14.5
220 29.1
330 43.5
441 57.8
551 71.6
661 85.0
772 98.3
882 111.8
992 125.3
1102 139.5
1210 153.8
1322 166.3
1432 180.2
1542 193.7
1652 207.3
1762 221.2
1872 235.0
1982 250.0
LOAD — LBS
100
200
300
400
500
600
700
800
900
1000
1100
DIAL READING — TEN THOUSANDTHS
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
FIG. 28

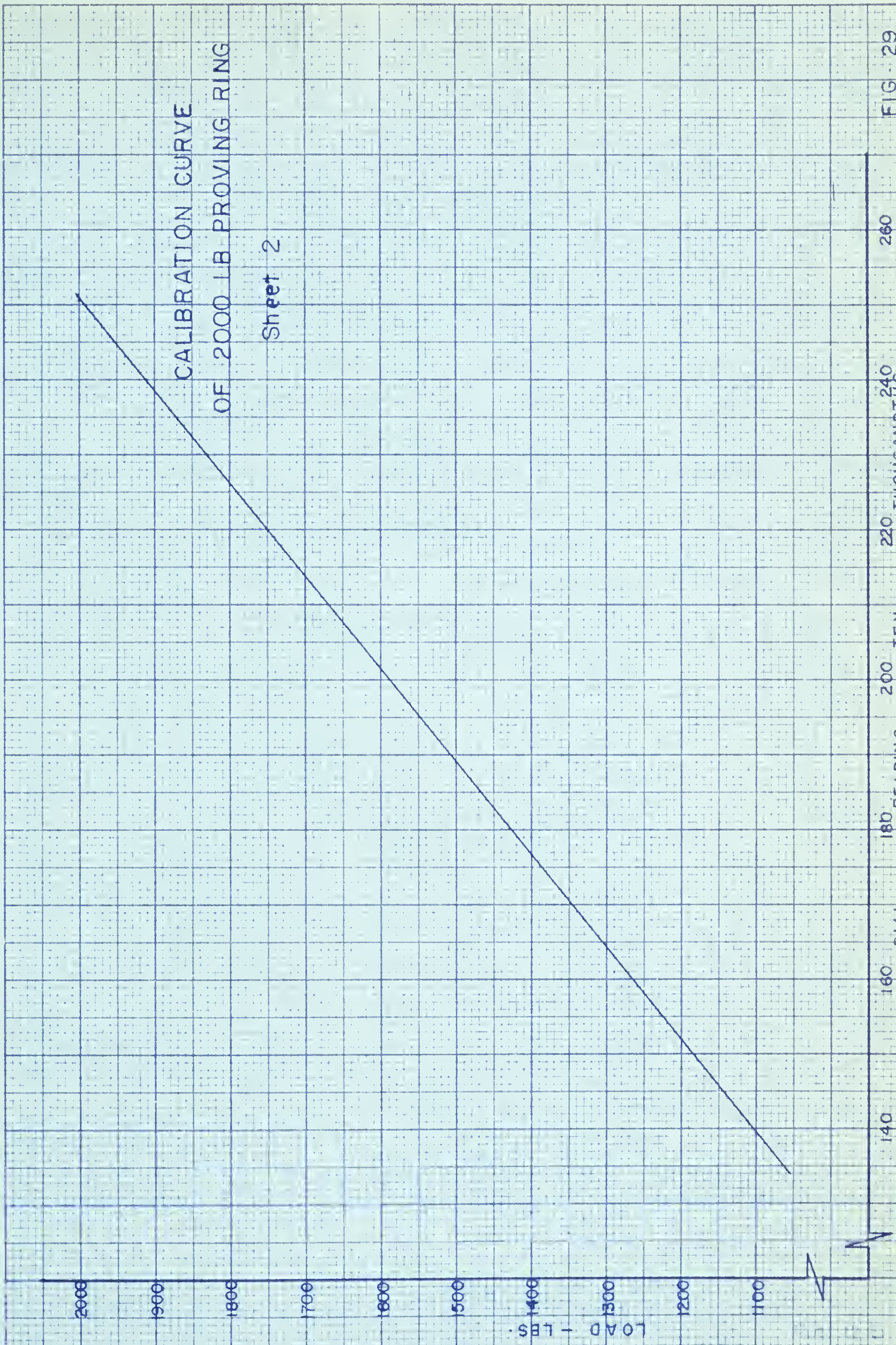

CALIBRATION CURVE
OF 2000 LB PROVING RING
Sheet 2
DIAL READING — TEN THOUSANDTHS
140
160
180
200
220
240
260
LOAD - LBS
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000

FIG. 29

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SOIL MECHANICS LABORATORY

COMPACTION TEST

PROJECT · LIME · POZZOLAN STABILIZATION
SITE
SAMPLE SOIL 16 · C · 1
LOCATION
HOLE DEPTH
TECHNICIAN P.K. DATE 12·12·60

l Number	1	2	3	4	5	6	
Mold · No·							
Wt. Sample Wet+Mold	6060	6156	6200	6290	6274	6251	
Wt. Mold	4354	4354	4354	4354	4354	4354	
Wt. Sample Wet	1706	1802	1846	1936	1920	1897	
Volume Mold	.033	.033	.033	.033	.033	.033	
Wet Unit Weight lb/ft^3	112.9	119.4	122.2	128.2	127.2	125.6	
Dry Unit Weight lb/ft^3	103.0	106.9	107.4	110.0	107.5	104.2	

Container No.	B	A	C	D	E	F	
Wt. Sample Wet + Tare	193.83	190.50	191.57	199.76	186.40	197.21	
Wt. Sample Dry + Tare	179.46	173.71	171.78	175.73	162.18	168.97	
Wt. Water	14.37	16.79	19.79	24.03	24.22	28.24	
Tare Container	29.50	30.70	29.40	31.00	30.30	30.60	
Wt. Dry Soil	149.96	143.01	142.38	144.73	131.88	138.37	
Moisture Content	9.6	11.7	13.9	16.6	18.4	20.4	

Max. Unit Wt. = ____ "/ft^3
Opt. Moist. = ____ %

Moisture Content %

Method of Compaction STANDARD PROCTOR COMPACTION
Diam. Mold 4.00"
Height Mold 4.58"
Volume Mold .033 ft^3
No. of Layers 3
Blows per Layer 25
Ht. of Free Fall 12"
Wt. of Tamper 5½ lb.
Shape of Tamping Face O
Description of Sample

Remarks Results plotted on master graph.

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DEP'T· of CIVIL ENGINEERING
SOIL MECHANICS LABORATORY
COMPACTION TEST

PROJECT· LIME· POZZOLAN · STABILIZATION
SITE
SAMPLE Soil 16 ·C· 1
LOCATION
HOLE DEPTH
TECHNICIAN P.K DATE 13·12·60

al Number	1	2	3	4	5	6	
Mold No·							
Wt· Sample Wet + Mold	6194	6277	6364	6419	6389	6323	
Wt· Mold	4354	4354	4354	4354	4354	4354	
Wt· Sample Wet	1840	1923	2010	2065	2035	1969	
Volume Mold ft³	·033	·033	·033	·033	·033	·033	
Wet Unit Weight lb/ft³	121·9	127·3	133·2	137·0	134·8	130·4	
Dry Unit Weight lb/ft³	115·3	118·2	120·4	121·5	117·4	111·5	
Container No·	B	G	H	J	K	A	Hygroscopic Moisture
Wt· Sample Wet + Tare	215·64	188·28	192·02	190·76	197·50	183·08	225·34
Wt· Sample Dry + Tare	205·66	176·84	176·63	172·49	176·11	160·91	222·16
Wt· Water	9·98	11·44	15·39	18·27	21·39	22·17	3·18
Tare Container	29·50	30·90	30·60	29·94	31·20	30·70	31·00
Wt· Dry Soil	176·16	145·94	146·03	142·55	144·91	130·21	191·16
Moisture Content	5·7	7·8	10·5	12·8	14·8	17·0	1·66

Max· Unit Wt· = ____ #/ft³
Opt· Moist· = ____ %

Moisture Content %

Method of Compaction Modified Proctor Compaction
Diam. Mold 4.00"
Height Mold 4.58"
Volume Mold 0.33 ft³
No· of Layers 5
Blows per Layer 25
Ht· of Free Fall 18"
Wt· of Tamper 10 lb.
Shape of Tamping Face O
Description of Sample

Remarks Results plotted on master graph.

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	5·0·0
Optimum Moisture Content	______ %	Lime-Pozzolan Ratio	______
Wt. Lime [nil %]	______ gm.	Percent Additive	______
Wt. Pozzolan [nil %]	______ gm.	Date Constructed	17·1·61
Wt. Soil	______ gm.	Date Broken	______
Wt. Dry Mix	______ gm.	**Results**	
Wt. Water	______ gm.	Aver. Dry Unit Wt. - pcf	______
Moulding Moisture Content		Aver. Unconf. Load - lbs.	______
Container No.	______	Aver. Unconf. Press. - psi	______
Wt. Wet Soil + Tare	______ gm.	Aver. Soaked Moist. - %	______
Wt. Dry Soil + Tare	______ gm.	Vol. of Lime - cf	______
Wt. Moisture	______ gm.	Vol. of Pozzolan - cf	______
Wt. Tare	______ gm.	Vol. of Soil - cf	______
Wt. Dry Soil	______ gm.	Vol. of Water - cf	______
Moisture Content	______ %	Vol. of Solids - cf	______

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.619	.535	.464	.358	.351	.405
Sample Height - inch	2.119	2.035	1.964	1.858	1.851	1.905
Wt. Wet Sample - gm.						
Dry Unit Wt. - pcf	102.9	105.3	107.8	110.7	110.3	104.4
Proving Dial - 0.0001						
Unconf. Load - lbs.						
Tare No.						
Wt. Wet Soil + Tare	197.78	197.90	198.51	198.00	197.00	197.33
Wt. Dry Soil + Tare	180.49	177.30	175.00	170.18	168.88	164.69
Wt. of Moisture	17.29	20.60	23.51	27.82	29.12	32.64
Wt. of Tare						
Wt. Dry Soil						
Soaked Moist. Cont. %	9.6	11.6	13.4	16.4	17.2	19.8
Soaked Dial Height						

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LIME POZZOLAN SOIL STABILIZATION

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		SERIES NO.	5·5·0
OPTIMUM MOISTURE CONTENT	______ %	LIME-POZZOLAN RATIO	______
WT. LIME [5 %]	______ GM.	PERCENT ADDITIVE	______
WT. POZZOLAN [nil %]	______ GM.	DATE CONSTRUCTED	21·1·61
WT. SOIL	______ GM.	DATE BROKEN	______
WT. DRY MIX	______ GM.	RESULTS	
WT. WATER	______ GM.	AVER. DRY UNIT WT. - PCF	______
MOULDING MOISTURE CONTENT		AVER. UNCONF. LOAD - LBS.	______
CONTAINER NO.	______	AVER. UNCONF. PRESS. - PSI	______
WT. WET SOIL + TARE	______ GM.	AVER. SOAKED MOIST. - %	______
WT. DRY SOIL + TARE	______ GM.	VOL. OF LIME - CF	______
WT. MOISTURE	______ GM.	VOL. OF POZZOLAN - CF	______
WT. TARE	______ GM.	VOL. OF SOIL - CF	______
WT. DRY SOIL	______ GM.	VOL. OF WATER - CF	______
MOISTURE CONTENT	______ %	VOL. OF SOLIDS - CF	______

SAMPLE NO:	1	2	3	4	5	6
HEIGHT DIAL - .0001	.636	.570	.433	.490		
SAMPLE HEIGHT - INCH	2.136	2.070	1.933	1.990		
WT. WET SAMPLE - GM.						
DRY UNIT WT. - PCF	99.8	101.5	102.5	99.4		
PROVING DIAL - 0.0001						
UNCONF. LOAD - LBS.	220	260	360	320		
TARE NO.						
WT. WET SOIL + TARE	197.30	198.70	193.28	198.21		
WT. DRY SOIL + TARE	175.05	172.00	163.80	163.50		
WT. OF MOISTURE	22.25	26.70	29.48	34.71		
WT. OF TARE						
WT. DRY SOIL						
SOAKED MOIST. CONT. %	12.7	15.5	18.0	21.2		
SOAKED DIAL HEIGHT						

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	5·40·0
Optimum Moisture Content	%	Lime-Pozzolan Ratio	
Wt. Lime [40 %]	gm.	Percent Additive	
Wt. Pozzolan [Nil %]	gm.	Date Constructed	19·1·61
Wt. Soil	gm.	Date Broken	
Wt. Dry Mix	gm.	**Results**	
Wt. Water	gm.	Aver. Dry Unit Wt. - pcf	
Moulding Moisture Content		Aver. Unconf. Load - lbs.	
Container No.		Aver. Unconf. Press. - psi	
Wt. Wet Soil + Tare	gm.	Aver. Soaked Moist. - %	
Wt. Dry Soil + Tare	gm.	Vol. of Lime - cf	
Wt. Moisture	gm.	Vol. of Pozzolan - cf	
Wt. Tare	gm.	Vol. of Soil - cf	
Wt. Dry Soil	gm.	Vol. of Water - cf	
Moisture Content	%	Vol. of Solids - cf	

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.900	.670	570	.488		
Sample Height - inch	2.400	2.170	2.070	1.988		
Wt. Wet Sample - gm.						
Dry Unit Wt. - pcf	80.3	83.8	84.3	83.8		
Proving Dial - 0.0001						
Unconf. Load - lbs.	136	—	229	167		
Tare No.						
Wt. Wet Soil + Tare	187.59	182.10	182.06	177.81		
Wt. Dry Soil + Tare	159.43	150.55	144.65	137.76		
Wt. of Moisture	28.16	31.55	37.41	40.05		
Wt. of Tare	nil	nil	nil	nil		
Wt. Dry Soil						
Soaked Moist. Cont. %	17.6	21.0	25.9	29.1		
Soaked Dial Height						

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	5·0·40
Optimum Moisture Content	%	Lime-Pozzolan Ratio	
Wt. Lime [nil %]	gm.	Percent Additive	
Wt. Pozzolan [40 %]	gm.	Date Constructed	10·1·61
Wt. Soil	gm.	Date Broken	
Wt. Dry Mix	gm.	**Results**	
Wt. Water	gm.	Aver. Dry Unit Wt. - pcf	
Moulding Moisture Content		Aver. Unconf. Load - lbs.	
Container No.		Aver. Unconf. Press. - psi	
Wt. Wet Soil + Tare	gm.	Aver. Soaked Moist. - %	
Wt. Dry Soil + Tare	gm.	Vol. of Lime - cf	
Wt. Moisture	gm.	Vol. of Pozzolan - cf	
Wt. Tare	gm.	Vol. of Soil - cf	
Wt. Dry Soil	gm.	Vol. of Water - cf	
Moisture Content	%	Vol. of Solids - cf	

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.936	.726	.709	.419	.457	.405
Sample Height - inch	2.436	2.226	2.209	1.919	1.957	1.905
Wt. Wet Sample - gm.						
Dry Unit Wt. - pcf	90.8	92.2	91.0	98.6	98.5	100.6
Proving Dial - 0.0001						
Unconf. Load - lbs.						
Tare No.						
Wt. Wet Soil + Tare	201.57	192.36	192.25	186.01	189.23	192.55
Wt. Dry Soil + Tare	183.02	169.83	168.65	156.79	159.71	158.45
Wt. of Moisture	18.55	22.53	23.60	29.22	29.52	34.10
Wt. of Tare						
Wt. Dry Soil						
Soaked Moist. Cont. %	10.1	13.2	14.0	18.3	18.5	21.5
Soaked Dial Height						

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LIME POZZOLAN SOIL STABILIZATION

		SERIES NO.	10·0·0
OPTIMUM MOISTURE CONTENT	______ %	LIME-POZZOLAN RATIO	______
WT. LIME [nil %]	______ GM.	PERCENT ADDITIVE	______
WT. POZZOLAN [nil %]	______ GM.	DATE CONSTRUCTED	17·1·61
WT. SOIL	______ GM.	DATE BROKEN	______
WT. DRY MIX	______ GM.	RESULTS	
WT. WATER	______ GM.	AVER. DRY UNIT WT. - PCF	______
MOULDING MOISTURE CONTENT		AVER. UNCONF. LOAD - LBS.	______
CONTAINER NO.	______	AVER. UNCONF. PRESS. - PSI	______
WT. WET SOIL + TARE	______ GM.	AVER. SOAKED MOIST. - %	______
WT. DRY SOIL + TARE	______ GM.	VOL. OF LIME - CF	______
WT. MOISTURE	______ GM.	VOL. OF POZZOLAN - CF	______
WT. TARE	______ GM.	VOL. OF SOIL - CF	______
WT. DRY SOIL	______ GM.	VOL. OF WATER - CF	______
MOISTURE CONTENT	______ %	VOL. OF SOLIDS - CF	______

SAMPLE NO.	1	2	3	4	5	6
HEIGHT DIAL - .0001	.442	.310	.330	.388		
SAMPLE HEIGHT - INCH	1.942	1.810	1.830	1.888		
WT. WET SAMPLE - GM.						
DRY UNIT WT. - PCF	111.7	116.5	112.0	107.6		
PROVING DIAL - 0.0001						
UNCONF. LOAD - LBS.						
TARE NO.						
WT. WET SOIL + TARE	198.50	198.10	197.08	200.80		
WT. DRY SOIL + TARE	179.30	174.41	169.46	168.10		
WT. OF MOISTURE	19.20	23.69	27.62	32.70		
WT. OF TARE						
WT. DRY SOIL						
SOAKED MOIST. CONT. %	10.7	13.6	16.3	19.4		
SOAKED DIAL HEIGHT						

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LIME POZZOLAN SOIL STABILIZATION

Optimum Moisture Content	____ %	Series No.	10.40.0
Wt. Lime [40 %]	____ gm.	Lime-Pozzolan Ratio	____
Wt. Pozzolan [nil %]	____ gm.	Percent Additive	____
Wt. Soil	____ gm.	Date Constructed	19.1.61
Wt. Dry Mix	____ gm.	Date Broken	____
Wt. Water	____ gm.	**Results**	
Moulding Moisture Content		Aver. Dry Unit Wt. - pcf	____
Container No.	____	Aver. Unconf. Load - lbs.	____
Wt. Wet Soil + Tare	____ gm.	Aver. Unconf. Press. - psi	____
Wt. Dry Soil + Tare	____ gm.	Aver. Soaked Moist. - %	____
Wt. Moisture	____ gm.	Vol. of Lime - cf	____
Wt. Tare	____ gm.	Vol. of Pozzolan - cf	____
Wt. Dry Soil	____ gm.	Vol. of Soil - cf	____
Moisture Content	____ %	Vol. of Water - cf	____
		Vol. of Solids - cf	____

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.704	.573	.529	.555		
Sample Height - inch	2.204	2.073	2.029	2.055		
Wt. Wet Sample - gm.						
Dry Unit Wt. - pcf	87.0	90.2	88.2	82.6		
Proving Dial - 0.0001						
Unconf. Load - lbs.	340	470	—	125		
Tare No.						
Wt. Wet Soil + Tare	186.75	188.00	186.35	181.14		
Wt. Dry Soil + Tare	158.43	154.78	148.10	140.28		
Wt. of Moisture	28.32	33.22	38.25	40.86		
Wt. of Tare						
Wt. Dry Soil						
Soaked Moist. Cont. %	17.9	21.5	25.8	29.2		
Soaked Dial Height						

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	10.5.0
Optimum Moisture Content	______ %	Lime-Pozzolan Ratio	______
Wt. Lime [5 %]	______ gm.	Percent Additive	______
Wt. Pozzolan [nil %]	______ gm.	Date Constructed	______
Wt. Soil	______ gm.	Date Broken	______
Wt. Dry Mix	______ gm.	Results	
Wt. Water	______ gm.	Aver. Dry Unit Wt. - pcf	______
Moulding Moisture Content		Aver. Unconf. Load - lbs.	______
Container No.	______	Aver. Unconf. Press. - psi	______
Wt. Wet Soil + Tare	______ gm.	Aver. Soaked Moist. - %	______
Wt. Dry Soil + Tare	______ gm.	Vol. of Lime - cf	______
Wt. Moisture	______ gm.	Vol. of Pozzolan - cf	______
Wt. Tare	______ gm.	Vol. of Soil - cf	______
Wt. Dry Soil	______ gm.	Vol. of Water - cf	______
Moisture Content	______ %	Vol. of Solids - cf	______

Sample No:	1	2	3	4	5	6
Height Dial - .0001	.519	.421	.366	.430		
Sample Height - inch	2.019	1.921	1.866	1.930		
Wt. Wet Sample - gm.						
Dry Unit Wt. - pcf	104.5	107.2	105.8	102.2		
Proving Dial - 0.0001						
Unconf. Load - lbs.	390	600	520	360		
Tare No.						
Wt. Wet Soil + Tare	196.43	197.20	192.94	197.70		
Wt. Dry Soil + Tare	174.61	169.92	163.22	163.08		
Wt. of Moisture	21.82	27.28	34.62	29.72		
Wt. of Tare						
Wt. Dry Soil						
Soaked Moist. Cont. %	12.5	16.1	18.2	21.2		
Soaked Dial Height						

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LIME POZZOLAN SOIL STABILIZATION

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		Series No.	10.0.40
Optimum Moisture Content	______ %	Lime-Pozzolan Ratio	______
Wt. Lime [nil %]	______ gm.	Percent Additive	______
Wt. Pozzolan [40 %]	______ gm.	Date Constructed	18.1.61
Wt. Soil	______ gm.	Date Broken	______
Wt. Dry Mix	______ gm.	Results	
Wt. Water	______ gm.	Aver. Dry Unit Wt. - pcf	______
Moulding Moisture Content		Aver. Unconf. Load - lbs.	______
Container No.	______	Aver. Unconf. Press. - psi	______
Wt. Wet Soil + Tare	______ gm.	Aver. Soaked Moist. - %	______
Wt. Dry Soil + Tare	______ gm.	Vol. of Lime - cf	______
Wt. Moisture	______ gm.	Vol. of Pozzolan - cf	______
Wt. Tare	______ gm.	Vol. of Soil - cf	______
Wt. Dry Soil	______ gm.	Vol. of Water - cf	______
Moisture Content	______ %	Vol. of Solids - cf	______

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.643	.417	.400	.375		
Sample Height - inch	2.143	1.917	1.900	1.875		
Wt. Wet Sample - gm.						
Dry Unit Wt. - pcf	93.8	100.2	100.1	96.5		
Proving Dial - 0.0001						
Unconf. Load - lbs.						
Tare No.						
Wt. Wet Soil + Tare	193.25	190.70	192.52	187.12		
Wt. Dry Soil + Tare	166.23	161.00	159.45	149.68		
Wt. of Moisture	27.02	29.70	33.07	37.44		
Wt. of Tare						
Wt. Dry Soil						
Soaked Moist. Cont. %	16.7	18.4	20.7	25.0		
Soaked Dial Height						

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	55·0·0
Optimum Moisture Content	____ %	Lime-Pozzolan Ratio	____
Wt. Lime [nil %]	____ gm.	Percent Additive	____
Wt. Pozzolan [nil %]	____ gm.	Date Constructed	17·1·61
Wt. Soil	____ gm.	Date Broken	____
Wt. Dry Mix	____ gm.	**Results**	
Wt. Water	____ gm.	Aver. Dry Unit Wt. - pcf	____
Moulding Moisture Content		Aver. Unconf. Load - lbs.	____
Container No.	____	Aver. Unconf. Press. - psi	____
Wt. Wet Soil + Tare	____ gm.	Aver. Soaked Moist. - %	____
Wt. Dry Soil + Tare	____ gm.	Vol. of Lime - cf	____
Wt. Moisture	____ gm.	Vol. of Pozzolan - cf	____
Wt. Tare	____ gm.	Vol. of Soil - cf	____
Wt. Dry Soil	____ gm.	Vol. of Water - cf	____
Moisture Content	____ %	Vol. of Solids - cf	____

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.408	.327	.307	.282	.237	.256
Sample Height - inch	1.908	1.827	1.807	1.782	1.737	1.756
Wt. Wet Sample - gm.						
Dry Unit Wt. - pcf	114·1	119·2	121·0	120·9	118·3	112·0
Proving Dial - 0.0001						
Unconf. Load - lbs.						
Tare No.						
Wt. Wet Soil + Tare	193.58	197.22	199.55	198.01	193.20	189.30
Wt. Dry Soil + Tare	180.16	179.54	180.30	178.02	168.80	162.49
Wt. of Moisture	13.42	17.68	19.25	19.99	24.40	26.81
Wt. of Tare						
Wt. Dry Soil						
Soaked Moist. Cont. %	7.4	9.9	10.7	11.2	14.4	16.5
Soaked Dial Height						

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LIME POZZOLAN SOIL STABILIZATION

Optimum Moisture Content	______ %	Series No.	55·40·0
Wt. Lime [40 %]	______ gm.	Lime-Pozzolan Ratio	______
Wt. Pozzolan [nil %]	______ gm.	Percent Additive	______
Wt. Soil	______ gm.	Date Constructed	14·1·61
Wt. Dry Mix	______ gm.	Date Broken	______
Wt. Water	______ gm.	**Results**	
Moulding Moisture Content		Aver. Dry Unit Wt. - pcf	______
Container No.	______	Aver. Unconf. Load - lbs.	______
Wt. Wet Soil + Tare	______ gm.	Aver. Unconf. Press. - psi	______
Wt. Dry Soil + Tare	______ gm.	Aver. Soaked Moist. - %	______
Wt. Moisture	______ gm.	Vol. of Lime - cf	______
Wt. Tare	______ gm.	Vol. of Pozzolan - cf	______
Wt. Dry Soil	______ gm.	Vol. of Soil - cf	______
Moisture Content	______ %	Vol. of Water - cf	______
		Vol. of Solids - cf	______

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.521	.495	.497	.469	.429	.535
Sample Height - inch	2.021	1.995	1.997	1.969	1.929	2.035
Wt. Wet Sample - gm.						
Dry Unit Wt. - pcf	96.6	96.3	95.3	89.6	88.6	85.1
Proving Dial - 0.0001						
Unconf. Load - lbs.	1100	—	730	—	260	1010
Tare No.						
Wt. Wet Soil + Tare	191.10	192.00	190.18	183.18	178.31	184.78
Wt. Dry Soil + Tare	161.22	158.90	156.96	145.81	141.43	143.10
Wt. of Moisture	29.88	33.10	33.22	37.37	36.88	41.68
Wt. of Tare						
Wt. Dry Soil						
Soaked Moist. Cont. %	18.5	20.8	21.2	25.6	26.1	29.2
Soaked Dial Height						

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	55·0·40
Optimum Moisture Content	______ %	Lime-Pozzolan Ratio	______
Wt. Lime [nil %]	______ gm.	Percent Additive	______
Wt. Pozzolan [40 %]	______ gm.	Date Constructed	10·1·61
Wt. Soil	______ gm.	Date Broken	______
Wt. Dry Mix	______ gm.	Results	
Wt. Water	______ gm.	Aver. Dry Unit Wt. - pcf	______
Moulding Moisture Content		Aver. Unconf. Load - lbs.	______
Container No.	______	Aver. Unconf. Press. - psi	______
Wt. Wet Soil + Tare	______ gm.	Aver. Soaked Moist. - %	______
Wt. Dry Soil + Tare	______ gm.	Vol. of Lime - cf	______
Wt. Moisture	______ gm.	Vol. of Pozzolan - cf	______
Wt. Tare	______ gm.	Vol. of Soil - cf	______
Wt. Dry Soil	______ gm.	Vol. of Water - cf	______
Moisture Content	______ %	Vol. of Solids - cf	______

Sample No:	1	2	3	4	5	6
Height Dial - .0001	.768	456	451	346	310	
Sample Height - inch	2.268	1.956	1.951	1.846	1.810	
Wt. Wet Sample - gm.						
Dry Unit Wt. - pcf	100.0	103.6	104.3	106.0	103.0	
Proving Dial - 0.0001						
Unconf. Load - lbs.						
Tare No.						
Wt. Wet Soil + Tare	205.59	190.00	192.43	191.90	187.69	
Wt. Dry Soil + Tare	187.38	167.68	168.52	161.90	154.42	
Wt. of Moisture	18.21	22.32	23.91	30.00	33.27	
Wt. of Tare						
Wt. Dry Soil						
Soaked Moist. Cont. %	9.7	13.3	14.2	18.5	21.6	
Soaked Dial Height						

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LIME POZZOLAN SOIL STABILIZATION

		SERIES NO.	55·5·0
OPTIMUM MOISTURE CONTENT	____ %	LIME-POZZOLAN RATIO	____
WT. LIME [5 %]	____ GM.	PERCENT ADDITIVE	____
WT. POZZOLAN [nil %]	____ GM.	DATE CONSTRUCTED	21·1·61
WT. SOIL	____ GM.	DATE BROKEN	____
WT. DRY MIX	____ GM.	RESULTS	
WT. WATER	____ GM.	AVER. DRY UNIT WT. - PCF	____
MOULDING MOISTURE CONTENT		AVER. UNCONF. LOAD - LBS.	____
CONTAINER NO.	____	AVER. UNCONF. PRESS. - PSI	____
WT. WET SOIL + TARE	____ GM.	AVER. SOAKED MOIST. - %	____
WT. DRY SOIL + TARE	____ GM.	VOL. OF LIME - CF	____
WT. MOISTURE	____ GM.	VOL. OF POZZOLAN - CF	____
WT. TARE	____ GM.	VOL. OF SOIL - CF	____
WT. DRY SOIL	____ GM.	VOL. OF WATER - CF	____
MOISTURE CONTENT	____ %	VOL. OF SOLIDS - CF	____

SAMPLE NO.	1	2	3	4	5	6
HEIGHT DIAL - .0001	.432	.332	.329	.260		
SAMPLE HEIGHT - INCH	1.932	1.832	1.829	1.760		
WT. WET SAMPLE - GM.						
DRY UNIT WT. - PCF	112.2	113.5	105.5	102.0		
PROVING DIAL - 0.0001						
UNCONF. LOAD - LBS.	1210	1320	540	400		
TARE NO.						
WT. WET SOIL + TARE	201.00	196.82	188.60	179.50		
WT. DRY SOIL + TARE	179.30	171.12	159.41	147.88		
WT. OF MOISTURE	21.70	25.70	29.19	31.62		
WT. OF TARE						
WT. DRY SOIL						
SOAKED MOIST. CONT. %	12.1	15.0	18.3	21.4		
SOAKED DIAL HEIGHT						

APPENDIX E

TEST DATA FOR THE FREEZE-THAW TEST OF LIME-POZZOLAN-SOIL SAMPLES

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LIME POZZOLAN SOIL STABILIZATION

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	(23.0)	Series No.	F.T. 5A
Optimum Moisture Content	20.0 %	Lime-Pozzolan Ratio	5:5
Wt. Lime [20 %]	280 gm.	Percent Additive	40
Wt. Pozzolan [20 %]	280 gm.	Date Constructed	23.1.61
Wt. Soil	840 gm.	Date Broken	
Wt. Dry Mix	1400 gm.	Results	
Wt. Water	280 gm.	Aver. Dry Unit Wt. - pcf	
Moulding Moisture Content		Aver. Unconf. Load - lbs.	
Container No.	J.103	Aver. Unconf. Press. - psi	
Wt. Wet Soil + Tare	143.35 gm.	Aver. Soaked Moist. - %	
Wt. Dry Soil + Tare	124.24 gm.	Vol. of Lime - cf	
Wt. Moisture	19.11 gm.	Vol. of Pozzolan - cf	
Wt. Tare	30.50 gm.	Vol. of Soil - cf	
Wt. Dry Soil	93.74 gm.	Vol. of Water - cf	
Moisture Content	20.2 %	Vol. of Solids - cf	

	I.C.	I.C.	F.T.	F.T.	F.C.	F.C.
Sample No.	1	2	3	4	5	6
Height Dial - .0001	.500	.490	.501	.511	.511	495
Sample Height - inch	2.000	1.990	2.001	2.011	2.011	1.995
Wt. Wet Sample - gm.	177.50	177.62	177.75	177.51	177.86	177.68
Dry Unit Wt. - pcf	89.5	90.0	89.5	89.2	89.3	89.7
					▽	
Proving Dial - 0.0001	64	71	—	—	75	79
Unconf. Load - lbs.	500	550	—	—	580	610
Tare No.	V.28	V.5	H.25	H.44	101	102
Wt. Wet Soil + Tare	124.90	114.51	150.49	205.26	149.33	135.08
Wt. Dry Soil + Tare	115.78	103.68	119.52	165.11	136.55	123.90
Wt. of Moisture	9.12	10.83	30.97	40.15	12.78	11.18
Wt. of Tare	82.58	65.44	30.02	40.22	92.60	83.51
Wt. Dry Soil	33.20	38.24	89.50	124.89	43.95	40.39
Soaked Moist. Cont. %	27.4	28.4	? 34.6	32.2	29.1	27.8
Soaked Dial Height	—	—	—	—	.510	.498

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LIME POZZOLAN SOIL STABILIZATION

	(22.0)	SERIES NO.	FTSP
OPTIMUM MOISTURE CONTENT	18.8 %	LIME-POZZOLAN RATIO	7:3
WT. LIME [21 %]	294 GM.	PERCENT ADDITIVE	30
WT. POZZOLAN [9 %]	126 GM.	DATE CONSTRUCTED	31.1.61
WT. SOIL	980 GM.	DATE BROKEN	
WT. DRY MIX	1400 GM.	RESULTS	
WT. WATER	263 GM.	AVER. DRY UNIT WT. - PCF	
MOULDING MOISTURE CONTENT		AVER. UNCONF. LOAD - LBS.	
CONTAINER NO.	J.140	AVER. UNCONF. PRESS. - PSI	
WT. WET SOIL + TARE	152.81 GM.	AVER. SOAKED MOIST. - %	
WT. DRY SOIL + TARE	134.80 GM.	VOL. OF LIME - CF	
WT. MOISTURE	18.01 GM.	VOL. OF POZZOLAN - CF	
WT. TARE	39.00 GM.	VOL. OF SOIL - CF	
WT. DRY SOIL	95.80 GM.	VOL. OF WATER - CF	
MOISTURE CONTENT	18.8 %	VOL. OF SOLIDS - CF	

SAMPLE NO.	1 (I.C.)	2 (I.C.)	3 (F.T.)	4 (F.T.)	5 (F.C.)	6 (F.C.)
HEIGHT DIAL - .0001	515	505	509	507	.506	.506
SAMPLE HEIGHT - INCH	2.015	2.005	2.009	2.007	2.006	2.006
WT. WET SAMPLE - GM.	181.07	180.91	181.10	180.94	180.90	180.85
DRY UNIT WT. - PCF	91.5	91.8	91.8	91.8	91.8	91.8
PROVING DIAL - 0.0001	31	31	—	—	39	35
UNCONF. LOAD - LBS.	235	235	—	—	300	270
TARE NO.	V.71	V.79	H.21		128	129
WT. WET SOIL + TARE	120.32	119.60	146.72		165.78	165.07
WT. DRY SOIL + TARE	111.49	108.10	118.55		150.21	150.34
WT. OF MOISTURE	8.83	11.50	28.17		15.57	14.73
WT. OF TARE	74.49	59.72	40.62		86.92	87.80
WT. DRY SOIL	37.00	48.38	77.93		63.29	62.54
SOAKED MOIST. CONT. %	23.8	23.8	36.2		24.6	23.5
SOAKED DIAL HEIGHT	—	—			.501	.504

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LIME POZZOLAN SOIL STABILIZATION

Optimum Moisture Content	(23.5) 19.6 %	Series No.	F.T. 5.Q
Wt. Lime [28 %]	392 gm.	Lime-Pozzolan Ratio	7:3
Wt. Pozzolan [12 %]	168 gm.	Percent Additive	40
Wt. Soil	840 gm.	Date Constructed	31.1.61
Wt. Dry Mix	1400 gm.	Date Broken	
Wt. Water	274 gm.	Results	
Moulding Moisture Content		Aver. Dry Unit Wt. - pcf	
Container No.	J.143	Aver. Unconf. Load - lbs.	
Wt. Wet Soil + Tare	136.48 gm.	Aver. Unconf. Press. - psi	
Wt. Dry Soil + Tare	119.22 gm.	Aver. Soaked Moist. - %	
Wt. Moisture	17.26 gm.	Vol. of Lime - cf	
Wt. Tare	30.40 gm.	Vol. of Pozzolan - cf	
Wt. Dry Soil	88.82 gm.	Vol. of Soil - cf	
Moisture Content	19.2 %	Vol. of Water - cf	
		Vol. of Solids - cf	

	I.C.	I.C.	F.T.	F.T.	F.C.	F.C.
Sample No.	1	2	3	4	5	6
Height Dial - .0001	.541	.495	.494	.493	.493	.517
Sample Height - inch	2.041	1.995	1.994	1.993	1.993	2.017
Wt. Wet Sample - gm.	176.14	172.08	172.58	172.52	172.54	172.87
Dry Unit Wt. - pcf	87.5	87.4	87.7	87.7	87.7	86.9
Proving Dial - 0.0001	35	38	—	—	50	42
Unconf. Load - lbs.	270	290	—	—	380	320
Tare No.	A.13	Y.31.15	H.42	H.41	130	131
Wt. Wet Soil + Tare	106.06	112.26	218.65	199.93	149.58	153.48
Wt. Dry Soil + Tare	97.42	100.68	171.52	158.30	135.20	138.05
Wt. of Moisture	8.64	11.58	47.13	41.63	14.38	15.43
Wt. of Tare	66.22	61.32	41.32	39.19	84.70	83.17
Wt. Dry Soil	31.20	39.36	130.20	119.11	50.50	54.88
Soaked Moist. Cont. %	27.6	29.4	36.2	34.9	28.5	28.2
Soaked Dial Height	—	—			.493	.518

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	F.T. 10.A
Optimum Moisture Content	(21.0) 16.7 %	Lime-Pozzolan Ratio	5:5
Wt. Lime [20 %]	300 gm.	Percent Additive	40
Wt. Pozzolan [20 %]	300 gm.	Date Constructed	23.1.61
Wt. Soil	900 gm.	Date Broken	
Wt. Dry Mix	1500 gm.	**Results**	
Wt. Water	250 gm.	Aver. Dry Unit Wt. - pcf	
Moulding Moisture Content		Aver. Unconf. Load - lbs.	
Container No.	J.102	Aver. Unconf. Press. - psi	
Wt. Wet Soil + Tare	140.52 gm.	Aver. Soaked Moist. - %	
Wt. Dry Soil + Tare	125.18 gm.	Vol. of Lime - cf	
Wt. Moisture	15.34 gm.	Vol. of Pozzolan - cf	
Wt. Tare	30.45 gm.	Vol. of Soil - cf	
Wt. Dry Soil	94.73 gm.	Vol. of Water - cf	
Moisture Content	16.2 %	Vol. of Solids - cf	

	I.C.	I.C.	F.T.	F.T.	F.C.	F.C.
Sample No.	L	2	3	4	5	6
Height Dial - .0001	.518	.505	.509	.522	.516	.506
Sample Height - inch	2.018	2.005	2.009	2.022	2.016	2.006
Wt. Wet Sample - gm.	180.38	178.63	179.18	179.50	178.94	179.41
Dry Unit Wt. - pcf	92.7	92.2	92.3	91.8	91.8	92.6
Proving Dial - 0.0001	86	89	–	–	104	105
Unconf. Load - lbs.	670	690			810	820
Tare No.	V.18	Y.6	H.52	H.50	103	104
Wt. Wet Soil + Tare	109.17	107.55	197.77	149.68	139.56	146.45
Wt. Dry Soil + Tare	98.81	99.21	162.10	125.12	128.48	134.10
Wt. of Moisture	10.36	8.34	35.67	24.56	11.08	12.35
Wt. of Tare	60.32	68.05	39.78	39.29	83.37	84.90
Wt. Dry Soil	38.49	31.16	122.32	85.83	45.11	49.20
Soaked Moist. Cont. %	26.9	26.8	29.1	28.6	24.6	25.1
Soaked Dial Height	–	–	–	–	.515	.504

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LIME POZZOLAN SOIL STABILIZATION

Optimum Moisture Content	(19.2) 15.6 %	Series No.	F.T. 10C
Wt. Lime [15 %]	210 gm.	Lime-Pozzolan Ratio	5:5
Wt. Pozzolan [15 %]	210 gm.	Percent Additive	30
Wt. Soil	980 gm.	Date Constructed	24.1.61
Wt. Dry Mix	1400 gm.	Date Broken	
Wt. Water	218 gm.	**Results**	
Moulding Moisture Content		Aver. Dry Unit Wt. - pcf	
Container No.	J.109	Aver. Unconf. Load - lbs.	
Wt. Wet Soil + Tare	179.72 gm.	Aver. Unconf. Press. - psi	
Wt. Dry Soil + Tare	159.65 gm.	Aver. Soaked Moist. - %	
Wt. Moisture	20.07 gm.	Vol. of Lime - cf	
Wt. Tare	30.25 gm.	Vol. of Pozzolan - cf	
Wt. Dry Soil	129.40 gm.	Vol. of Soil - cf	
Moisture Content	15.5 %	Vol. of Water - cf	
		Vol. of Solids - cf	

	I.C.	I.C.	F.T.	F.T.	F.C.	F.C
Sample No.	1	2	3	4	5	6
Height Dial - .0001	.505	.511	533	.534	545	.547
Sample Height - inch	2.005	2.011	2.033	2.034	2.045	2.047
Wt. Wet Sample - gm.	184.30	183.01	183.67	184.04	184.23	184.92
Dry Unit Wt. - pcf	96.1	96.2	94.5	94.6	94.2	94.5
Proving Dial - 0.0001	64	65	—	—	65	67
Unconf. Load - lbs.	490	500	—	—	500	520
Tare No.	V.70	V.50	H.38	H.27	109	110
Wt. Wet Soil + Tare	109.42	140.98	208.12	203.32	156.09	151.41
Wt. Dry Soil + Tare	100.65	129.35	166.85	168.12	143.50	140.58
Wt. of Moisture	8.77	11.63	41.27	35.20	12.59	10.83
Wt. of Tare	59.97	81.41	26.30	39.98	92.01	91.92
Wt. Dry Soil	40.68	47.94	140.55	128.14	51.49	48.66
Soaked Moist. Cont. %	18.7	24.3	29.3	27.4	24.5	22.3
Soaked Dial Height	—	—	—	—	.542	.543

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LIME POZZOLAN SOIL STABILIZATION

Optimum Moisture Content	(17.5) 14.5 %	Series No.	F.T. 10.D
Wt. Lime [10 %]	140 gm.	Lime-Pozzolan Ratio	5:5
Wt. Pozzolan [10 %]	140 gm.	Percent Additive	20
Wt. Soil	1120 gm.	Date Constructed	25·1·61
Wt. Dry Mix	1400 gm.	Date Broken	
Wt. Water	209 gm.	**Results**	
Moulding Moisture Content		Aver. Dry Unit Wt. - pcf	
Container No.	J·111	Aver. Unconf. Load - lbs.	
Wt. Wet Soil + Tare	132.13 gm.	Aver. Unconf. Press. - psi	
Wt. Dry Soil + Tare	118.95 gm.	Aver. Soaked Moist. - %	
Wt. Moisture	23.18 gm.	Vol. of Lime - cf	
Wt. Tare	29.35 gm.	Vol. of Pozzolan - cf	
Wt. Dry Soil	89.60 gm.	Vol. of Soil - cf	
Moisture Content	14.7 %	Vol. of Water - cf	
		Vol. of Solids - cf	

	I.C.	I.C.	F.T.	F.T.	F.C.	F.C.
Sample No.	1	2	3	4	5	6
Height Dial - .0001	.461	.486	.501	.492	.500	.492
Sample Height - inch	1.961	1.986	2.001	1.992	2.000	1.992
Wt. Wet Sample - gm.	187.22	188.47	189.41	188.49	189.05	188.90
Dry Unit Wt. - pcf	100.6	99.5	99.7	99.7	99.6	99.9
Proving Dial - 0.0001	50	46	—	—	52	51
Unconf. Load - lbs.	380	350	—	—	400	390
Tare No.	V.47	V.65	H.20	123	124	125
Wt. Wet Soil + Tare	106.05	119.40	220.09	228.80	157.90	150.10
Wt. Dry Soil + Tare	98.80	109.88	177.30	188.48	145.20	138.56
Wt. of Moisture	7.25	9.52	42.79	40.32	12.70	11.54
Wt. of Tare	63.90	64.68	30.05	40.62	85.98	84.50
Wt. Dry Soil	34.90	45.20	147.25	147.86	59.22	54.06
Soaked Moist. Cont. %	20.7	21.0	29.1	27.3	21.8	21.4
Soaked Dial Height	—	—	—	—	.503	.490

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LIME POZZOLAN SOIL STABILIZATION

Optimum Moisture Content	(17.8) 14.2 %	Series No.	F.T. 10N
Wt. Lime [14 %]	196 gm.	Lime-Pozzolan Ratio	7:3
Wt. Pozzolan [6 %]	84 gm.	Percent Additive	20
Wt. Soil	1120 gm.	Date Constructed	30·1·61
Wt. Dry Mix	1400 gm.	Date Broken	
Wt. Water	199 gm.	**Results**	
Moulding Moisture Content		Aver. Dry Unit Wt. - pcf	
Container No.	J.138	Aver. Unconf. Load - lbs.	
Wt. Wet Soil + Tare	128.98 gm.	Aver. Unconf. Press. - psi	
Wt. Dry Soil + Tare	115.12 gm.	Aver. Soaked Moist. - %	
Wt. Moisture	13.86 gm.	Vol. of Lime - cf	
Wt. Tare	22.50 gm.	Vol. of Pozzolan - cf	
Wt. Dry Soil	92.62 gm.	Vol. of Soil - cf	
Moisture Content	15.0 %	Vol. of Water - cf	
		Vol. of Solids - cf	

	I.C.	I.C.	F.T.	F.T.	F.C.	F.C.
Sample No.	1	2	3	4	5	6
Height Dial - .0001	.478	.476	.495	.500	.494	.493
Sample Height - inch	1.978	1.976	1.995	2.000	1.994	1.993
Wt. Wet Sample - gm.	186.09	186.41	186.85	187.22	187.69	187.82
Dry Unit Wt. - pcf	98.8	99.1	98.4	98.3	98.9	99.0
Proving Dial - 0.0001	45	46	—	—	46	47
Unconf. Load - lbs.	340	350	—	—	350	360
Tare No.	V.85	V.82	H.53	H.51	123	122
Wt. Wet Soil + Tare	151.97	123.02	182.30	235.76	169.40	148.69
Wt. Dry Soil + Tare	139.13	112.00	150.12	194.40	156.69	136.80
Wt. of Moisture	12.84	11.02	32.18	41.36	12.71	11.89
Wt. of Tare	80.28	60.05	39.48	40.14	92.61	79.80
Wt. Dry Soil	58.85	51.95	120.64	154.26	64.08	57.00
Soaked Moist. Cont. %	21.9	21.3	26.7	26.8	19.8	20.9
Soaked Dial Height	—	—	—	—	.494	.490

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LIME POZZOLAN SOIL STABILIZATION

OPTIMUM MOISTURE CONTENT	(19.5) 14.8 %	SERIES NO.	F.T. 10.P
WT. LIME [21 %]	294 GM.	LIME-POZZOLAN RATIO	7:3
WT. POZZOLAN [9 %]	126 GM.	PERCENT ADDITIVE	30
WT. SOIL	980 GM.	DATE CONSTRUCTED	31.1.61
WT. DRY MIX	1400 GM.	DATE BROKEN	
WT. WATER	207 GM.	RESULTS	
MOULDING MOISTURE CONTENT		AVER. DRY UNIT WT. - PCF	
CONTAINER NO.	J.142	AVER. UNCONF. LOAD - LBS.	
WT. WET SOIL + TARE	131.89 GM.	AVER. UNCONF. PRESS. - PSI	
WT. DRY SOIL + TARE	118.48 GM.	AVER. SOAKED MOIST. - %	
WT. MOISTURE	13.41 GM.	VOL. OF LIME - CF	
WT. TARE	31.31 GM.	VOL. OF POZZOLAN - CF	
WT. DRY SOIL	87.17 GM.	VOL. OF SOIL - CF	
MOISTURE CONTENT	15.4 %	VOL. OF WATER - CF	
		VOL. OF SOLIDS - CF	

	I C.	I C.	F.T.	F.T.	F.C.	F.C.
SAMPLE NO:	1	2	3	4	5	6
HEIGHT DIAL - .0001	.532	.501	.506	.514	.513	.514
SAMPLE HEIGHT - INCH	2.032	2.001	2.006	2.014	2.013	2.014
WT. WET SAMPLE - GM.	181.32	180.22	179.38	179.80	180.31	180.40
DRY UNIT WT. - PCF	93.7	94.3	93.6	93.4	93.8	93.8
PROVING DIAL - 0.0001	44	48	—	—	52	57
UNCONF. LOAD - LBS.	340	370	—	—	400	440
TARE NO.	Y.63	V.78		H.36	126	127
WT. WET SOIL + TARE	111.11	137.81		220.12	153.23	160.59
WT. DRY SOIL + TARE	103.11	127.22		176.60	140.59	148.28
WT. OF MOISTURE	8.00	10.59		53.52	12.64	12.31
WT. OF TARE	66.72	82.61		45.90	84.23	83.90
WT. DRY SOIL	36.39	44.61		130.70	56.36	64.38
SOAKED MOIST. CONT. %	22.0	23.7		33.3	22.5	19.2
SOAKED DIAL HEIGHT	—	—			.507	.509

LIME POZZOLAN SOIL STABILIZATION

Series No. FT 10Q

Optimum Moisture Content 15.3 %

Lime-Pozzolan Ratio 7:3

Wt. Lime [28 %] 392 gm.

Percent Additive 40

Wt. Pozzolan [12 %] 168 gm.

Date Constructed 1 · 2 · 61

Wt. Soil 840 gm.

Date Broken

Wt. Dry Mix 1400 gm.

Wt. Water 214 gm.

Moulding Moisture Content

Container No. J.144

Wt. Wet Soil + Tare 123.81 gm.

Wt. Dry Soil + Tare 111.41 gm.

Wt. Moisture 12.40 gm.

Wt. Tare 29.88 gm.

Wt. Dry Soil 81.53 gm.

Moisture Content 15.7 %

Results

Aver. Dry Unit Wt. - pcf

Aver. Unconf. Load - lbs.

Aver. Unconf. Press. - psi

Aver. Soaked Moist. - %

Vol. of Lime - cf

Vol. of Pozzolan - cf

Vol. of Soil - cf

Vol. of Water - cf

Vol. of Solids - cf

	I.C.	I.C.	F.T.	F.T.	F.C.	F.C.
Sample No.	1	2	3	4	5	6
Height Dial - .0001	.527	.527	.523	.513	.510	.534
Sample Height - inch	2.027	2.027	2.023	2.013	2.010	2.034
Wt. Wet Sample - gm.	175.00	175.41	174.14	174.10	173.66	173.40
Dry Unit Wt. - pcf	90.4	90.6	90.1	90.5	90.4	89.2
						▽
Proving Dial - 0.0001	62	57	—	—	65	66
Unconf. Load - lbs.	480	440	—	—	500	510
Tare No.	A.14	V.76	H.34	H.35	120	121
Wt. Wet Soil + Tare	93.12	89.95	172.39	211.80	155.17	148.82
Wt. Dry Soil + Tare	86.88	84.09	144.90	170.00	140.20	134.25
Wt. of Moisture	6.24	5.86	27.49	41.80	14.97	14.57
Wt. of Tare	62.80	61.50	41.59	40.76	81.52	84.76
Wt. Dry Soil	24.08	22.59	103.31	129.24	58.68	49.49
Soaked Moist. Cont. %	25.9	26.0	26.6	32.3	25.5	29.4
Soaked Dial Height	—	—			.516	.533

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LIME POZZOLAN SOIL STABILIZATION

Optimum Moisture Content	(18.0) 14.4 %	Series No.	F.T. 55A
Wt. Lime [20 %]	300 gm.	Lime-Pozzolan Ratio	5:5
Wt. Pozzolan [20 %]	300 gm.	Percent Additive	40
Wt. Soil	900 gm.	Date Constructed	23.1.61
Wt. Dry Mix	1500 gm.	Date Broken	
Wt. Water	216 gm.	Results	
Moulding Moisture Content		Aver. Dry Unit Wt. - pcf	
Container No.	J101	Aver. Unconf. Load - lbs.	
Wt. Wet Soil + Tare	132.18 gm.	Aver. Unconf. Press. - psi	
Wt. Dry Soil + Tare	119.86 gm.	Aver. Soaked Moist. - %	
Wt. Moisture	12.32 gm.	Vol. of Lime - cf	
Wt. Tare	30.59 gm.	Vol. of Pozzolan - cf	
Wt. Dry Soil	89.27 gm.	Vol. of Soil - cf	
Moisture Content	13.8 %	Vol. of Water - cf	
		Vol. of Solids - cf	

	I.C.	I.C.	F.T.	F.T.	F.C.	F.C.
Sample No.	1	2	3	4	5	6
Height Dial - .0001	.497	.520	.550	.537	.495	.516
Sample Height - inch	1.997	2.020	2.050	2.037	1.995	2.016
Wt. Wet Sample - gm.	187.62	189.62	191.02	187.77	187.50	186.89
Dry Unit Wt. - pcf	99.3	99.1	98.5	97.5	99.4	98.1
					▽	
Proving Dial - 0.0001	160	166	—	—	192	160
Unconf. Load - lbs.	1260	1310	—	—	1530	1260
Tare No.	V.74	V.29	H.43	H.48	105	106
Wt. Wet Soil + Tare	107.32	102.82	80.18	207.75	134.05	152.49
Wt. Dry Soil + Tare	99.72	96.10	69.25	173.30	124.35	137.82
Wt. of Moisture	7.60	6.72	10.93	34.45	9.70	14.67
Wt. of Tare	66.54	66.29	23.77	38.82	83.35	74.35
Wt. Dry Soil	33.18	29.81	45.48	134.48	41.00	63.47
Soaked Moist. Cont. %	22.9	22.5	24.0	25.6	23.7	23.2
Soaked Dial Height	—	—	—	—	.497	.517

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LIME POZZOLAN SOIL STABILIZATION

	(18.0)	SERIES NO.	F.T.55B
OPTIMUM MOISTURE CONTENT	15.8 %	LIME-POZZOLAN RATIO	3:7
WT. LIME [12 %]	180 GM.	PERCENT ADDITIVE	40
WT. POZZOLAN [28 %]	420 GM.	DATE CONSTRUCTED	23.1.61
WT. SOIL	900 GM.	DATE BROKEN	
WT. DRY MIX	1500 GM.	RESULTS	
WT. WATER	237 GM.	AVER. DRY UNIT WT. - PCF	
MOULDING MOISTURE CONTENT		AVER. UNCONF. LOAD - LBS.	
CONTAINER NO.	J.104	AVER. UNCONF. PRESS. - PSI	
WT. WET SOIL + TARE	130.43 GM.	AVER. SOAKED MOIST. - %	
WT. DRY SOIL + TARE	116.88 GM.	VOL. OF LIME - CF	
WT. MOISTURE	13.55 GM.	VOL. OF POZZOLAN - CF	
WT. TARE	29.42 GM.	VOL. OF SOIL - CF	
WT. DRY SOIL	87.46 GM.	VOL. OF WATER - CF	
MOISTURE CONTENT	15.5 %	VOL. OF SOLIDS - CF	

	I.C.	I.C.	F.T.	F.T.	F.C.	F.C.
SAMPLE NO:	1	2	3	4	5	6
HEIGHT DIAL - .0001	.522	.503	510	515	.496	.512
SAMPLE HEIGHT - INCH	2.022	2.003	2.010	2.015	1.996	2.012
WT. WET SAMPLE - GM.	196.81	194.18	193.36	195.80	193.42	192.76
DRY UNIT WT. - PCF	101.8	101.4	100.6	101.6	101.4	100.2
PROVING DIAL - 0.0001	192	170	–	–	182	171
UNCONF. LOAD - LBS.	1530	1350	–	–	1450	1360
TARE NO.	V.27	V.26	H.46	H47	107	108
WT. WET SOIL + TARE	91.81	112.18	201.93	185.04	148.81	154.93
WT. DRY SOIL + TARE	85.50	104.15	169.75	153.68	137.32	142.60
WT. OF MOISTURE	6.31	8.03	32.18	31.36	11.49	12.33
WT. OF TARE	57.82	68.50	38.99	26.31	84.52	90.29
WT. DRY SOIL	27.68	35.65	130.76	127.37	52.80	52.31
SOAKED MOIST. CONT. %	22.8	22.5	24.6	24.6	21.8	23.6
SOAKED DIAL HEIGHT	–	–			.500	.518

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LIME POZZOLAN SOIL STABILIZATION

Optimum Moisture Content	(16.5) 14.0 %	Series No.	F.T. 55C
Wt. Lime [15 %]	210 gm.	Lime-Pozzolan Ratio	5:5
Wt. Pozzolan [15 %]	210 gm.	Percent Additive	30
Wt. Soil	980 gm.	Date Constructed	24·1·61
Wt. Dry Mix	1400 gm.	Date Broken	
Wt. Water	196 gm.	**Results**	
Moulding Moisture Content		Aver. Dry Unit Wt. - pcf	
		Aver. Unconf. Load - lbs.	
Container No.	J.107	Aver. Unconf. Press. - psi	
Wt. Wet Soil + Tare	134.92 gm.	Aver. Soaked Moist. - %	
Wt. Dry Soil + Tare	121.47 gm.	Vol. of Lime - cf	
Wt. Moisture	13.45 gm.	Vol. of Pozzolan - cf	
Wt. Tare	30.40 gm.	Vol. of Soil - cf	
Wt. Dry Soil	91.07 gm.	Vol. of Water - cf	
Moisture Content	14.7 %	Vol. of Solids - cf	

Sample No.	I.C. 1	I.C. 2	F.T. 3	F.T. 4	F.C. 5	F.C. 6
Height Dial - .0001	.519	.493	.472	.544	511	507
Sample Height - inch	2.019	1.993	1.972	2.044	2.011	2.007
Wt. Wet Sample - gm.	197.02	193.89	193.04	195.32	194.81	194.77
Dry Unit Wt. - pcf	102.0	102.4	103.1	100.6	102.0	102.2
Proving Dial - 0.0001	.123	.126	—	—	125	131
Unconf. Load - lbs.	970	990	—	—	980	1030
Tare No.	V.59	V.44	H.30	H.30	112	113
Wt. Wet Soil + Tare	109.54	116.32	168.53	213.07	148.64	140.78
Wt. Dry Soil + Tare	101.71	106.60	144.70	178.00	138.85	131.95
Wt. of Moisture	7.83	9.72	23.83	35.97	9.79	8.83
Wt. of Tare	64.04	58.41	39.73	40.90	92.14	89.58
Wt. Dry Soil	37.67	48.19	104.97	137.10	46.71	42.37
Soaked Moist. Cont. %	20.8	20.2	22.7	? 26.2	20.7	20.8
Soaked Dial Height	—	—	—	—	.512	.506

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LIME POZZOLAN SOIL STABILIZATION

		SERIES NO.	F.T. 55N
OPTIMUM MOISTURE CONTENT	12.3 %	LIME-POZZOLAN RATIO	7:3
WT. LIME [14 %]	196 GM.	PERCENT ADDITIVE	20
WT. POZZOLAN [6 %]	84 GM.	DATE CONSTRUCTED	30·1·61
WT. SOIL	1120 GM.	DATE BROKEN	
WT. DRY MIX	1400 GM.	RESULTS	
WT. WATER	172 GM.	AVER. DRY UNIT WT. - PCF	
MOULDING MOISTURE CONTENT		AVER. UNCONF. LOAD - LBS.	
CONTAINER NO.	J.137	AVER. UNCONF. PRESS. - PSI	
WT. WET SOIL + TARE	107.08 GM.	AVER. SOAKED MOIST. - %	
WT. DRY SOIL + TARE	96.90 GM.	VOL. OF LIME - CF	
WT. MOISTURE	10.18 GM.	VOL. OF POZZOLAN - CF	
WT. TARE	18.83 GM.	VOL. OF SOIL - CF	
WT. DRY SOIL	78.07 GM.	VOL. OF WATER - CF	
MOISTURE CONTENT	13.0 %	VOL. OF SOLIDS - CF	

	I.C.	I.C.	F.T.	F.T.	F.C.	F.C.
SAMPLE NO.	1	2	3	4	5	6
HEIGHT DIAL - .0001	.537	.471	484	.508	.506	.487
SAMPLE HEIGHT - INCH	2.037	1.971	1.984	2.008	2.006	1.987
WT. WET SAMPLE - GM.	199.88	196.10	195.58	196.77	197.12	196.68
DRY UNIT WT. - PCF	104.9	106.3	105.4	104.8	105.0	105.8
	TESTED 8·3·31					∇
PROVING DIAL - 0.0001	101	82	—	—	102	104
UNCONF. LOAD - LBS.	790	640	—	—	800	810
TARE NO.	V·28	V·66	H·54	H·49	116	117
WT. WET SOIL + TARE	143.23	120.55	178.72	127.72	163.61	161.51
WT. DRY SOIL + TARE	133.37	112.42	153.48	109.05	151.30	150.70
WT. OF MOISTURE	9.86	8.13	25.24	18.67	12.31	10.81
WT. OF TARE	82.58	66.30	40.13	26.14	86.28	94.73
WT. DRY SOIL	50.79	46.12	113.35	82.91	65.02	55.97
SOAKED MOIST. CONT. %	19.5	17.6	22.3	22.5	18.9	19.3
SOAKED DIAL HEIGHT	—	—			.499	.481

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LIME POZZOLAN SOIL STABILIZATION

Optimum Moisture Content	(16.8) 12.8 %	Series No.	F.T. 55P
Wt. Lime [21 %]	294 gm.	Lime-Pozzolan Ratio	7:3
Wt. Pozzolan [9 %]	126 gm.	Percent Additive	30
Wt. Soil	980 gm.	Date Constructed	31.1.61
Wt. Dry Mix	1400 gm.	Date Broken	
Wt. Water	179 gm.	Results	
Moulding Moisture Content		Aver. Dry Unit Wt. - pcf	
Container No.	J.141	Aver. Unconf. Load - lbs.	
Wt. Wet Soil + Tare	140.41 gm.	Aver. Unconf. Press. - psi	
Wt. Dry Soil + Tare	128.82 gm.	Aver. Soaked Moist. - %	
Wt. Moisture	11.59 gm.	Vol. of Lime - cf	
Wt. Tare	40.56 gm.	Vol. of Pozzolan - cf	
Wt. Dry Soil	88.26 gm.	Vol. of Soil - cf	
Moisture Content	13.2 %	Vol. of Water - cf	
		Vol. of Solids - cf	

	I.C.	I.C.	F.T.	F.T.	F.C.	F.C.
Sample No.	1	2	3	4	5	6
Height Dial - .0001	.487	500	516	.513	517	496
Sample Height - inch	1.987	2.000	2.016	2.013	2.017	1.996
Wt. Wet Sample - gm.	189.12	189.79	191.21	190.32	190.23	188.52
Dry Unit Wt. - pcf	101.6	101.2	101.2	100.9	100.6	100.8
Proving Dial - 0.0001	92	105	—	—	116	112
Unconf. Load - lbs.	720	820	—	—	910	880
Tare No.	V.49	A.27	H.33	H.37	118	119
Wt. Wet Soil + Tare	118.00	103.17	219.80	215.25	141.20	132.47
Wt. Dry Soil + Tare	108.60	96.07	185.80	179.55	131.28	125.12
Wt. of Moisture	9.40	7.10	34.00	35.70	9.92	7.35
Wt. of Tare	62.90	61.35	40.93	39.55	82.87	87.80
Wt. Dry Soil	45.70	34.72	144.87	140.00	48.41	37.32
Soaked Moist. Cont. %	20.6	20.4	23.5	25.5	20.5	19.7
Soaked Dial Height	—	—			.515	.487

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LIME POZZOLAN SOIL STABILIZATION

Optimum Moisture Content	(18.0) 13.0 %	Series No.	F.T. 55Q
Wt. Lime [28 %]	392 gm.	Lime-Pozzolan Ratio	7:3
Wt. Pozzolan [12 %]	168 gm.	Percent Additive	40
Wt. Soil	840 gm.	Date Constructed	1.2.61
Wt. Dry Mix	1400 gm.	Date Broken	
Wt. Water	182 gm.	**Results**	
Moulding Moisture Content		Aver. Dry Unit Wt. - pcf	
Container No.	J.145	Aver. Unconf. Load - lbs.	
Wt. Wet Soil + Tare	154.82 gm.	Aver. Unconf. Press. - psi	
Wt. Dry Soil + Tare	140.73 gm.	Aver. Soaked Moist. - %	
Wt. Moisture	14.09 gm.	Vol. of Lime - cf	
Wt. Tare	30.85 gm.	Vol. of Pozzolan - cf	
Wt. Dry Soil	109.88 gm.	Vol. of Soil - cf	
Moisture Content	12.8 %	Vol. of Water - cf	
		Vol. of Solids - cf	

	I.C.	I.C.	F.T.	F.T.	F.T.	F.T.
Sample No.	1	2	3	4	5	6
Height Dial - .0001	.492	.510	524	.521	.522	.511
Sample Height - inch	1.992	2.010	2.024	2.021	2.022	2.011
Wt. Wet Sample - gm.	181.01	184.36	185.03	184.32	183.72	184.68
Dry Unit Wt. - pcf	97.5	98.2	97.8	97.8	97.3	98.3
Proving Dial - 0.0001	102	126	—	—	—	—
Unconf. Load - lbs.	800	990	—	—	—	—
Tare No.	V.33	A.25	H.29	H.28		H.40
Wt. Wet Soil + Tare	117.39	95.97	217.34	201.40		201.40
Wt. Dry Soil + Tare	109.95	89.57	182.28	169.00		167.90
Wt. of Moisture	7.44	6.40	35.06	32.40		33.50
Wt. of Tare	75.18	60.48	40.11	40.43		40.68
Wt. Dry Soil	34.77	29.09	142.17	128.57		127.22
Soaked Moist. Cont. %	21.4	22.0	24.7	25.2		26.3
Soaked Dial Height						

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LIME POZZOLAN SOIL STABILIZATION

	(16.8)	Series No.	F.T. 55·12
Optimum Moisture Content	11·8 %	Lime-Pozzolan Ratio	9 : 1
Wt. Lime [27 %]	378 gm.	Percent Additive	30
Wt. Pozzolan [3 %]	42 gm.	Date Constructed	1·2·61
Wt. Soil	980 gm.	Date Broken	
Wt. Dry Mix	1400 gm.	Results	
Wt. Water	165 gm.	Aver. Dry Unit Wt. - pcf	
Moulding Moisture Content		Aver. Unconf. Load - lbs.	
Container No.	J·146	Aver. Unconf. Press. - psi	
Wt. Wet Soil + Tare	96.42 gm.	Aver. Soaked Moist. - %	
Wt. Dry Soil + Tare	88.45 gm.	Vol. of Lime - cf	
Wt. Moisture	7·97 gm.	Vol. of Pozzolan - cf	
Wt. Tare	18·80 gm.	Vol. of Soil - cf	
Wt. Dry Soil	69·65 gm.	Vol. of Water - cf	
Moisture Content	11·9 %	Vol. of Solids - cf	

	I.C.	I.C.	F.T.	F.T	F.C.	F.C.
Sample No:	1	2	3	4	5	6
Height Dial - .0001	.507	.476	.488	.510	.522	.491
Sample Height - inch	2.007	1.976	1.988	2.010	2.022	1.991
Wt. Wet Sample - gm.	184.47	182.53	183.02	184.32	184.43	183.20
Dry Unit Wt. - pcf	99.2	99.7	99.4	99.0	98.5	99.3
Proving Dial - 0.0001	98	107			104	95
Unconf. Load - lbs.	765	840			810	740
Tare No.	V.22	A.17	H.31	H.26	114	115
Wt. Wet Soil + Tare	110.69	114.40	218.48	170.52	134.22	153.10
Wt. Dry Soil + Tare	104.40	107.02	184.50	145.61	126.50	142.82
Wt. of Moisture	6.29	7.38	33.98	24.91	7.72	10.28
Wt. of Tare	73.95	70.19	40.50	40.85	86.83	91.55
Wt. Dry Soil	30.45	36.83	144.00	104.76	39.66	51.27
Soaked Moist. Cont. %	20.6	20.0	23.6	24.8	19.4	20.0
Soaked Dial Height	—	—	—	—	.516	.486

APPENDIX F

TEST DATA FOR STRENGTH-DENSITY RELATIONS FOR COMPACTED SAMPLES OF LIME-POZZOLAN-SOIL

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	5A
Optimum Moisture Content	23.0 %	Lime-Pozzolan Ratio	5:5
Wt. Lime [20 %]	280 gm.	Percent Additive	40
Wt. Pozzolan [20 %]	280 gm.	Date Constructed	7.2.61
Wt. Soil	840 gm.	Date Broken	8.3.61
Wt. Dry Mix	1400 gm.	Results	
Wt. Water	322 gm.	Aver. Dry Unit Wt. - pcf	92.9
Moulding Moisture Content		Aver. Unconf. Load - lbs.	500
Container No.	J-193	Aver. Unconf. Press. - psi	159
Wt. Wet Soil + Tare	188.97 gm.	Aver. Soaked Moist. - %	24.7
Wt. Dry Soil + Tare	160.97 gm.	Vol. of Lime - cf	.132
Wt. Moisture	28.00 gm.	Vol. of Pozzolan - cf	.109
Wt. Tare	40.62 gm.	Vol. of Soil - cf	.326
Wt. Dry Soil	120.35 gm.	Vol. of Water - cf	.346
Moisture Content	23.2 %	Vol. of Solids - cf	.567

Sample No.	L1	12	13	14	15	16
Height Dial - .0001	.482	.514	.509	.503	.519	.511
Sample Height - inch	1.982	2.014	2.009	2.003	2.019	2.011
Wt. Wet Sample - gm.	188.22	190.28	190.24	189.98	190.57	190.52
Dry Unit Wt. - pcf	93.2	92.6	93.0	92.9	92.6	92.9
Proving Dial - 0.0001	64	64	68	65	65	63
Unconf. Load - lbs.	500	500	530	500	500	490
Tare No.	V.26	V.41	V.71	V.5	V.47	H.51
Wt. Wet Soil + Tare	127.13	109.62	131.88	119.19	118.38	114.62
Wt. Dry Soil + Tare	115.56	98.85	120.52	108.60	107.61	99.84
Wt. of Moisture	11.57	10.77	11.36	10.59	10.77	14.78
Wt. of Tare	68.50	56.10	74.49	65.44	63.90	40.14
Wt. Dry Soil	47.06	42.75	46.03	43.16	43.71	59.70
Soaked Moist. Cont. %	24.5	25.2	24.6	24.5	24.6	24.7
Soaked Dial Height	.482	.515	.509	.503	.518	.514

LIME POZZOLAN SOIL STABILIZATION

		Series No.	58
Optimum Moisture Content	22.0 %	Lime-Pozzolan Ratio	3:7
Wt. Lime [12 %]	168 gm.	Percent Additive	40
Wt. Pozzolan [28 %]	392 gm.	Date Constructed	24.1.61
Wt. Soil	840 gm.	Date Broken	22.2.61
Wt. Dry Mix	1400 gm.	Results	
Wt. Water	308 gm.	Aver. Dry Unit Wt. - pcf	91.6
Moulding Moisture Content		Aver. Unconf. Load - lbs.	700
Container No.	J.106	Aver. Unconf. Press. - psi	223
Wt. Wet Soil + Tare	143.51 gm.	Aver. Soaked Moist. - %	27.2
Wt. Dry Soil + Tare	123.80 gm.	Vol. of Lime - cf	.079
Wt. Moisture	19.71 gm.	Vol. of Pozzolan - cf	.150
Wt. Tare	31.10 gm.	Vol. of Soil - cf	.321
Wt. Dry Soil	92.70 gm.	Vol. of Water - cf	.312
Moisture Content	21.3 %	Vol. of Solids - cf	.550

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.494	.514	.499	.508	.525	.517
Sample Height - inch	1.994	2.014	1.999	2.008	2.025	2.017
Wt. Wet Sample - gm.	184.45	184.55	184.30	184.68	184.69	184.90
Dry Unit Wt. - pcf	92.3	91.2	91.8	91.7	91.0	91.3
Proving Dial - 0.0001	83	94	91	88	86.0	95
Unconf. Load - lbs.	650	730	710	690	670	740
Tare No.	V.70	V.28	A.17	V.31	V.26	A.14
Wt. Wet Soil + Tare	111.02	127.72	120.20	112.66	112.55	105.02
Wt. Dry Soil + Tare	100.12	118.05	109.80	101.50	102.82	95.98
Wt. of Moisture	10.90	9.67	10.40	11.16	9.73	9.04
Wt. of Tare	59.97	82.58	70.19	61.32	68.50	62.80
Wt. Dry Soil	41.15	35.47	39.61	40.18	34.32	33.18
Soaked Moist. Cont. %	26.5	27.2	26.3	27.8	28.3	27.2
Soaked Dial Height	.505	.522	.511	.518	.537	—

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	5c
Optimum Moisture Content	21.5 %	Lime-Pozzolan Ratio	5:5
Wt. Lime [15 %]	210 gm.	Percent Additive	30
Wt. Pozzolan [15 %]	210 gm.	Date Constructed	24.1.61
Wt. Soil	980 gm.	Date Broken	22.2.61
Wt. Dry Mix	1400 gm.	Results	
Wt. Water	301 gm.	Aver. Dry Unit Wt. - pcf	92.7
Moulding Moisture Content		Aver. Unconf. Load - lbs.	320
Container No.	J.110	Aver. Unconf. Press. - psi	102
Wt. Wet Soil + Tare	138.46 gm.	Aver. Soaked Moist. - %	24.5
Wt. Dry Soil + Tare	121.08 gm.	Vol. of Lime - cf	.099
Wt. Moisture	17.38 gm.	Vol. of Pozzolan - cf	.081
Wt. Tare	31.28 gm.	Vol. of Soil - cf	.379
Wt. Dry Soil	89.80 gm.	Vol. of Water - cf	.288
Moisture Content	19.4 %	Vol. of Solids - cf	.559

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.513	.512	.510	.528	.526	.521
Sample Height - inch	2.013	2.012	2.010	2.028	2.026	2.021
Wt. Wet Sample - gm.	184.79	184.96	184.08	184.93	185.00	185.04
Dry Unit Wt. - pcf	92.9	93.2	92.7	92.3	92.3	92.7
Proving Dial - 0.0001	38	39	42	44	45	40
Unconf. Load - lbs.	290	300	320	340	340	310
Tare No.	V.44	V.59	A.13	V.71	V.78	V.66
Wt. Wet Soil + Tare	96.11	116.91	107.46	120.04	134.23	123.48
Wt. Dry Soil + Tare	88.97	106.99	99.20	110.83	123.91	112.13
Wt. of Moisture	7.14	9.92	8.26	9.21	10.32	11.35
Wt. of Tare	58.41	64.04	66.22	74.49	82.61	66.30
Wt. Dry Soil	30.56	42.95	32.98	36.34	41.30	45.83
Soaked Moist. Cont. %	23.4	23.1	25.1	25.4	25.0	24.8
Soaked Dial Height	—	.516	.510	.532	.528	.524

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LIME POZZOLAN SOIL STABILIZATION

		SERIES NO.	5 D
OPTIMUM MOISTURE CONTENT	19.8 %	LIME-POZZOLAN RATIO	5:5
WT. LIME [10 %]	140 GM.	PERCENT ADDITIVE	20
WT. POZZOLAN [10 %]	140 GM.	DATE CONSTRUCTED	25·1·61
WT. SOIL	1120 GM.	DATE BROKEN	23·2·61
WT. DRY MIX	1400 GM.	RESULTS	
WT. WATER	278 GM.	AVER. DRY UNIT WT. - PCF	97.7
MOULDING MOISTURE CONTENT		AVER. UNCONF. LOAD - LBS.	280
CONTAINER NO.	J·112	AVER. UNCONF. PRESS. - PSI	89
WT. WET SOIL + TARE	134.20 GM.	AVER. SOAKED MOIST. - %	22.1
WT. DRY SOIL + TARE	118.11 GM.	VOL. OF LIME - CF	.069
WT. MOISTURE	16.09 GM.	VOL. OF POZZOLAN - CF	.057
WT. TARE	30.91 GM.	VOL. OF SOIL - CF	.456
WT. DRY SOIL	87.20 GM.	VOL. OF WATER - CF	.288
MOISTURE CONTENT	18.4 %	VOL. OF SOLIDS - CF	.582

SAMPLE NO.	1	2	3	4	5	6
HEIGHT DIAL - .0001	.479	.512	.486	.509	.513	.537
SAMPLE HEIGHT - INCH	1.979	2.012	1.986	2.009	2.013	2.037
WT. WET SAMPLE - GM.	191.30	192.07	190.93	191.56	192.50	192.42
DRY UNIT WT. - PCF	98.8	97.7	98.2	97.4	97.7	96.6
PROVING DIAL - 0.0001	38	38	37	38	36	30
UNCONF. LOAD - LBS.	290	290	280	290	270	230
TARE NO.	V 71	A·13	V·5	V·66	V·33	V·18
WT. WET SOIL + TARE	136.13	119.14	117.38	136.60	116.80	121.69
WT. DRY SOIL + TARE	125.07	109.62	108.08	123.86	109.18	110.42
WT. OF MOISTURE	11.06	9.52	9.30	12.74	7.62	11.27
WT. OF TARE	74.49	66.22	65.44	66.30	75.18	60.32
WT. DRY SOIL	50.58	43.40	42.64	57.56	34.00	50.10
SOAKED MOIST. CONT. %	21.8	21.9	21.8	22.1	22.4	22.5
SOAKED DIAL HEIGHT	.487	.520	.497	.514	.521	.550

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	5E
Optimum Moisture Content	18.1 %	Lime-Pozzolan Ratio	5:5
Wt. Lime [5 %]	70 gm.	Percent Additive	10
Wt. Pozzolan [5 %]	70 gm.	Date Constructed	25.1.61
Wt. Soil	1260 gm.	Date Broken	23.2.61
Wt. Dry Mix	1400 gm.	Results	
Wt. Water	253 gm.	Aver. Dry Unit Wt. - pcf	100.7
Moulding Moisture Content		Aver. Unconf. Load - lbs.	200
Container No.	J.115	Aver. Unconf. Press. - psi	64
Wt. Wet Soil + Tare	152.42 gm.	Aver. Soaked Moist. - %	20.8
Wt. Dry Soil + Tare	133.80 gm.	Vol. of Lime - cf	.036
Wt. Moisture	18.62 gm.	Vol. of Pozzolan - cf	.029
Wt. Tare	30.46 gm.	Vol. of Soil - cf	.540
Wt. Dry Soil	103.34 gm.	Vol. of Water - cf	.290
Moisture Content	18.0 %	Vol. of Solids - cf	.605

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.497	.463	.511	.505	.526	.530
Sample Height - inch	1.997	1.963	2.011	2.005	2.026	2.030
Wt. Wet Sample - gm.	196.00	194.52	197.80	197.91	198.40	197.68
Dry Unit Wt. - pcf	100.6	101.6	100.9	101.2	100.3	99.8
Proving Dial - 0.0001	26	26	25	28	27	24
Unconf. Load - lbs.	200	200	190	210	200	180
Tare No.	V.70	V.74	V.78	V.79	A.25	V.26
Wt. Wet Soil + Tare	122.53	122.25	142.56	117.50	118.07	125.44
Wt. Dry Soil + Tare	111.88	112.78	132.00	107.58	108.47	115.52
Wt. of Moisture	10.65	9.47	10.56	9.92	9.60	9.92
Wt. of Tare	59.97	66.54	82.61	59.72	60.48	68.50
Wt. Dry Soil	51.91	46.24	49.39	47.86	47.99	47.02
Soaked Moist. Cont. %	21.2	20.5	21.4	20.7	20.0	21.1
Soaked Dial Height	.496	.466	.516	.507	.533	.537

LIME POZZOLAN SOIL STABILIZATION

		Series No.	5F
Optimum Moisture Content	17.8 %	Lime-Pozzolan Ratio	5:5
Wt. Lime [3 %]	42 gm.	Percent Additive	6
Wt. Pozzolan [3 %]	42 gm.	Date Constructed	26·1·61
Wt. Soil	1316 gm.	Date Broken	24·2·61
Wt. Dry Mix	1400 gm.	**Results**	
Wt. Water	249 gm.	Aver. Dry Unit Wt. - pcf	103.4
Moulding Moisture Content		Aver. Unconf. Load - lbs.	220
Container No.	J·118	Aver. Unconf. Press. - psi	70
Wt. Wet Soil + Tare	136.51 gm.	Aver. Soaked Moist. - %	19.6
Wt. Dry Soil + Tare	120.77 gm.	Vol. of Lime - cf	.022
Wt. Moisture	15.74 gm.	Vol. of Pozzolan - cf	.018
Wt. Tare	30.91 gm.	Vol. of Soil - cf	.568
Wt. Dry Soil	89.86 gm.	Vol. of Water - cf	.290
Moisture Content	17.5 %	Vol. of Solids - cf	.608

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.513	531	.538	.510	.519	.524
Sample Height - inch	2.013	2.031	2.038	2.010	2.019	2.024
Wt. Wet Sample - gm.	202.93	202.91	203.07	203.32	203.30	203.03
Dry Unit Wt. - pcf	103.8	102.9	102.5	104.2	103.8	103.2
Proving Dial - 0.0001	26	27	26	28	31	31
Unconf. Load - lbs.	200	200	200	210	240	240
Tare No.	A·14·14	A·13	V 85	A 14	V·59	V·79
Wt. Wet Soil + Tare	116.05	124.98	133.56	125.54	119.59	105.36
Wt. Dry Soil + Tare	107.28	115.25	124.70	115.50	110.50	98.00
Wt. of Moisture	8.77	9.73	8.86	10.04	9.09	7.36
Wt. of Tare	62.75	66.22	80.28	62.80	64.04	59.72
Wt. Dry Soil	44.53	49.03	44.42	52.70	46.46	38.28
Soaked Moist. Cont. %	19.7	19.8	20.0	19.1	19.6	19.2
Soaked Dial Height	.513	.531	.541	.512	.522	.526

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LIME POZZOLAN SOIL STABILIZATION

Optimum Moisture Content	21.0 %	Series No.	5G
Wt. Lime [9 %]	126 gm.	Lime-Pozzolan Ratio	3:7
Wt. Pozzolan [21 %]	294 gm.	Percent Additive	30
Wt. Soil	980 gm.	Date Constructed	26·1·61
Wt. Dry Mix	1400 gm.	Date Broken	24·2·61
Wt. Water	294 gm.	**Results**	
Moulding Moisture Content		Aver. Dry Unit Wt. - pcf	95.3
Container No.	J.121	Aver. Unconf. Load - lbs.	470
Wt. Wet Soil + Tare	142.02 gm.	Aver. Unconf. Press. - psi	150
Wt. Dry Soil + Tare	123.48 gm.	Aver. Soaked Moist. - %	24.5
Wt. Moisture	18.54 gm.	Vol. of Lime - cf	.061
Wt. Tare	29.90 gm.	Vol. of Pozzolan - cf	.117
Wt. Dry Soil	93.58 gm.	Vol. of Soil - cf	.390
Moisture Content	19.8 %	Vol. of Water - cf	.303
		Vol. of Solids - cf	.568

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.491	.525	.520	.532	.524	.524
Sample Height - inch	1.991	2.025	2.020	2.032	2.024	2.024
Wt. Wet Sample - gm.	189.58	190.93	190.89	190.82	190.87	190.89
Dry Unit Wt. - pcf	96.2	95.2	95.3	94.8	95.1	95.2
Proving Dial - 0.0001	64	62	62	59	60	60
Unconf. Load - lbs.	500	480	460	450	460	460
Tare No.	V.66	V.71	V.65	V.18	A.17	V.44
Wt. Wet Soil + Tare	118.02	136.60	125.23	109.58	126.45	119.58
Wt. Dry Soil + Tare	107.85	124.58	113.18	99.90	115.24	107.51
Wt. of Moisture	10.17	12.02	12.05	9.68	11.21	12.07
Wt. of Tare	66.30	74.49	64.68	60.32	70.19	58.41
Wt. Dry Soil	41.55	50.09	48.50	39.58	45.05	49.10
Soaked Moist. Cont. %	24.5	24.0	24.8	24.4	24.9	24.6
Soaked Dial Height	.496	.534	.527	.542	.533	.532

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	5H
Optimum Moisture Content	19.2 %	Lime-Pozzolan Ratio	3:7
Wt. Lime [6 %]	84 gm.	Percent Additive	20
Wt. Pozzolan [14 %]	196 gm.	Date Constructed	27·1·61
Wt. Soil	1120 gm.	Date Broken	25·2·61
Wt. Dry Mix	1400 gm.	**Results**	
Wt. Water	269 gm.	Aver. Dry Unit Wt. - pcf	98.7
Moulding Moisture Content		Aver. Unconf. Load - lbs.	340
Container No.	J.124	Aver. Unconf. Press. - psi	108
Wt. Wet Soil + Tare	142.75 gm.	Aver. Soaked Moist. - %	22.3
Wt. Dry Soil + Tare	124.50 gm.	Vol. of Lime - cf	.042
Wt. Moisture	18.25 gm.	Vol. of Pozzolan - cf	.081
Wt. Tare	29.42 gm.	Vol. of Soil - cf	.462
Wt. Dry Soil	95.08 gm.	Vol. of Water - cf	.303
Moisture Content	19.2 %	Vol. of Solids - cf	.585

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.489	.496	.502	.522	.504	.528
Sample Height - inch	1.989	1.996	2.002	2.022	2.004	2.028
Wt. Wet Sample - gm.	195.30	194.88	195.00	195.29	195.22	195.38
Dry Unit Wt. - pcf	99.7	99.2	98.8	97.8	98.9	97.7
Proving Dial - 0.0001	47	44	44	43	45	44
Unconf. Load - lbs.	360	340	340	330	340	340
Tare No.	V.65	V31.15	V.33	V.28	V.26	V.74
Wt. Wet Soil + Tare	129.73	121.62	153.40	151.85	136.85	119.22
Wt. Dry Soil + Tare	117.98	110.70	139.16	139.02	124.42	109.60
Wt. of Moisture	11.75	10.92	14.24	12.83	12.43	9.62
Wt. of Tare	64.68	61.32	75.18	82.58	68.50	66.54
Wt. Dry Soil	53.30	49.38	63.98	56.44	55.92	43.06
Soaked Moist. Cont. %	22.1	22.2	22.3	22.7	22.2	22.3
Soaked Dial Height	.500	.506	.510	.527	.512	.496

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	5J
Optimum Moisture Content	18.0 %	Lime-Pozzolan Ratio	3:7
Wt. Lime [3 %]	42 gm.	Percent Additive	10
Wt. Pozzolan [7 %]	98 gm.	Date Constructed	27·1·61
Wt. Soil	1260 gm.	Date Broken	25·2·61
Wt. Dry Mix	1400 gm.	Results	
Wt. Water	252 gm.	Aver. Dry Unit Wt. - pcf	103.0
Moulding Moisture Content		Aver. Unconf. Load - lbs.	280
Container No.	Omitted	Aver. Unconf. Press. - psi	89
Wt. Wet Soil + Tare	gm.	Aver. Soaked Moist. - %	20.5
Wt. Dry Soil + Tare	gm.	Vol. of Lime - cf	.022
Wt. Moisture	gm.	Vol. of Pozzolan - cf	.042
Wt. Tare	gm.	Vol. of Soil - cf	.542
Wt. Dry Soil	gm.	Vol. of Water - cf	.288
Moisture Content	Use 17.5 %	Vol. of Solids - cf	.606

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.523	.475	.504	.509	.516	.502
Sample Height - inch	2.023	1.975	2.004	2.009	2.016	2.002
Wt. Wet Sample - gm.	201.88	200.42	199.75	200.51	200.12	200.32
Dry Unit Wt. - pcf	102.7	104.7	102.6	102.8	102.2	103.00
Proving Dial - 0.0001	36	42	36	37	36	35
Unconf. Load - lbs.	270	320	270	280	270	270
Tare No.	V·18	A·13	A·17	Y.85	Y.5	Y.59
Wt. Wet Soil + Tare	129.98	134.78	133.06	160.38	131.76	141.05
Wt. Dry Soil + Tare	118.08	123.58	122.35	146.55	120.30	127.88
Wt. of Moisture	11.90	11.20	10.71	13.83	11.46	13.17
Wt. of Tare	60.32	66.22	70.19	80.28	65.44	64.04
Wt. Dry Soil	57.76	57.36	52.16	66.27	54.86	63.84
Soaked Moist. Cont. %	20.6	19.5	20.5	20.8	20.9	20.6
Soaked Dial Height	.525	.476	.505	.507	.517	.509

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	5K
Optimum Moisture Content	21.3 %	Lime-Pozzolan Ratio	1:9
Wt. Lime [4 %]	56 gm.	Percent Additive	40
Wt. Pozzolan [36 %]	506 gm.	Date Constructed	27 · 1 · 61
Wt. Soil	838 gm.	Date Broken	25 · 2 · 61
Wt. Dry Mix	1400 gm.	**Results**	
Wt. Water	298 gm.	Aver. Dry Unit Wt. - pcf	93.1
Moulding Moisture Content		Aver. Unconf. Load - lbs.	770
Container No.	J.130	Aver. Unconf. Press. - psi	245
Wt. Wet Soil + Tare	135.15 gm.	Aver. Soaked Moist. - %	27.5
Wt. Dry Soil + Tare	117.11 gm.	Vol. of Lime - cf	.026
Wt. Moisture	18.04 gm.	Vol. of Pozzolan - cf	.196
Wt. Tare	31.27 gm.	Vol. of Soil - cf	.327
Wt. Dry Soil	85.84 gm.	Vol. of Water - cf	.312
Moisture Content	21.0 %	Vol. of Solids - cf	.549

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.550	.531	523	.556	.547	.534
Sample Height - inch	2.050	2.031	2.023	2.056	2.047	2.034
Wt. Wet Sample - gm.	191.98	189.98	188.14	190.22	189.74	189.18
Dry Unit Wt. - pcf	93.7	93.6	92.8	92.6	92.7	92.9
Proving Dial - 0.0001	98	107	104	77	94	107
Unconf. Load - lbs.	770	840	810	600	730	840
	▽					
Tare No.	A.27	A.25	V.47	V.71	A.3	V.78
Wt. Wet Soil + Tare	108.92	115.50	108.13	134.55	117.92	144.50
Wt. Dry Soil + Tare	98.40	103.91	98.88	120.73	105.65	131.18
Wt. of Moisture	10.52	11.59	9.25	13.82	12.27	13.32
Wt. of Tare	61.35	60.48	63.90	74.49	58.85	82.61
Wt. Dry Soil	37.05	43.43	34.98	46.24	46.80	48.57
Soaked Moist. Cont. %	28.4	26.7	26.4	29.9	26.1	27.5
Soaked Dial Height	.575	.550	539	.588	.562	.552

▽ Sample Soaked During Curing Period

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	5 L
Optimum Moisture Content	20.1 %	Lime-Pozzolan Ratio	1:9
Wt. Lime [3 %]	42 gm.	Percent Additive	30
Wt. Pozzolan [27 %]	378 gm.	Date Constructed	30·1·61
Wt. Soil	980 gm.	Date Broken	28·1·61
Wt. Dry Mix	1400 gm.	**Results**	
Wt. Water	291 gm.	Aver. Dry Unit Wt. - pcf	97.5
Moulding Moisture Content		Aver. Unconf. Load - lbs.	660
Container No.	J.133	Aver. Unconf. Press. - psi	210
Wt. Wet Soil + Tare	145.93 gm.	Aver. Soaked Moist. - %	24.4
Wt. Dry Soil + Tare	126.58 gm.	Vol. of Lime - cf	.021
Wt. Moisture	19.35 gm.	Vol. of Pozzolan - cf	.154
Wt. Tare	30.35 gm.	Vol. of Soil - cf	.399
Wt. Dry Soil	96.23 gm.	Vol. of Water - cf	.314
Moisture Content	20.1 %	Vol. of Solids - cf	.574

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.495	512	.503	.513	.522	.508
Sample Height - inch	1.995	2.012	2.003	2.013	2.022	2.008
Wt. Wet Sample - gm.	193.30	194.02	193.89	193.94	194.09	194.17
Dry Unit Wt. - pcf	97.7	97.2	97.3	97.1	96.7	97.5
Proving Dial - 0.0001	90	85	85	87	83	81
Unconf. Load - lbs.	700	660	660	680	650	630
Tare No.	V76	A.14	Y.64.81	V.18	V.28	V.74
Wt. Wet Soil + Tare	108.27	123.40	124.01	121.57	136.07	120.76
Wt. Dry Soil + Tare	99.98	111.59	112.90	109.69	125.51	110.23
Wt. of Moisture	9.29	11.81	11.11	11.88	10.56	10.43
Wt. of Tare	61.50	62.75	66.41	60.32	82.58	66.54
Wt. Dry Soil	38.48	48.84	46.49	49.37	42.93	43.69
Soaked Moist. Cont. %	24.1	25.2	25.0	24.1	24.6	23.9
Soaked Dial Height	.495	.522	.516	.530	.533	.517

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	5M
Optimum Moisture Content	18.2 %	Lime-Pozzolan Ratio	7:3
Wt. Lime [7 %]	98 gm.	Percent Additive	10
Wt. Pozzolan [3 %]	42 gm.	Date Constructed	30·1·61
Wt. Soil	1260 gm.	Date Broken	28·2·61
Wt. Dry Mix	1400 gm.	**Results**	
Wt. Water	255 gm.	Aver. Dry Unit Wt. - pcf	100.8
Moulding Moisture Content		Aver. Unconf. Load - lbs.	200
Container No.	J.134	Aver. Unconf. Press. - psi	64
Wt. Wet Soil + Tare	149.35 gm.	Aver. Soaked Moist. - %	20.3
Wt. Dry Soil + Tare	131.32 gm.	Vol. of Lime - cf	.051
Wt. Moisture	18.03 gm.	Vol. of Pozzolan - cf	.018
Wt. Tare	30.42 gm.	Vol. of Soil - cf	.530
Wt. Dry Soil	100.90 gm.	Vol. of Water - cf	.288
Moisture Content	17.9 %	Vol. of Solids - cf	.599

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.532	507	.515	.504	.501	.484
Sample Height - inch	2.032	2.007	2.015	2.004	2.001	1.984
Wt. Wet Sample - gm.	199.93	197.75	198.08	196.80	195.94	195.16
Dry Unit Wt. - pcf	101.0	101.2	100.8	100.6	100.4	100.8
Proving Dial - 0.0001	26	26	27	27	25	27
Unconf. Load - lbs.	200	200	200	200	190	200
Tare No.	A.3	V.33	V.31.15	V.41	Y.44	A.25
Wt. Wet Soil + Tare	121.60	140.62	118.40	124.65	126.54	122.21
Wt. Dry Soil + Tare	111.00	129.50	108.81	113.10	115.14	111.83
Wt. of Moisture	10.60	11.12	9.59	11.55	11.40	10.38
Wt. of Tare	58.85	75.18	61.32	56.10	58.41	60.48
Wt. Dry Soil	52.15	54.32	47.49	57.00	56.73	51.35
Soaked Moist. Cont. %	20.3	20.5	20.2	20.3	20.1	20.2
Soaked Dial Height	.530	.507	.510	.499	.497	.475

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LIME POZZOLAN SOIL STABILIZATION

		SERIES NO.	5N
OPTIMUM MOISTURE CONTENT	20.0 %	LIME-POZZOLAN RATIO	7:3
WT. LIME [14 %]	196 GM.	PERCENT ADDITIVE	20
WT. POZZOLAN [6 %]	84 GM.	DATE CONSTRUCTED	31·1·61
WT. SOIL	1120 GM.	DATE BROKEN	1·3·61
WT. DRY MIX	1400 GM.	RESULTS	
WT. WATER	280 GM.	AVER. DRY UNIT WT. - PCF	95.8
MOULDING MOISTURE CONTENT		AVER. UNCONF. LOAD - LBS.	210
CONTAINER NO.	J.139	AVER. UNCONF. PRESS. - PSI	67
WT. WET SOIL + TARE	148.78 GM.	AVER. SOAKED MOIST. - %	21.6
WT. DRY SOIL + TARE	130.51 GM.	VOL. OF LIME - CF	.095
WT. MOISTURE	18.27 GM.	VOL. OF POZZOLAN - CF	.034
WT. TARE	31.30 GM.	VOL. OF SOIL - CF	.448
WT. DRY SOIL	99.21 GM.	VOL. OF WATER - CF	.282
MOISTURE CONTENT	18.4 %	VOL. OF SOLIDS - CF	.577

SAMPLE NO.	1	2	3	4	5	6
HEIGHT DIAL - .0001	.482	.492	.489	.483	.497	.500
SAMPLE HEIGHT - INCH	1.982	1.992	1.989	1.983	1.997	2.000
WT. WET SAMPLE - GM.	186.33	187.52	186.70	187.13	187.15	187.29
DRY UNIT WT. - PCF	96.2	95.1	95.9	96.3	95.8	95.6
PROVING DIAL - 0.0001	29	25	27	28	27	28
UNCONF. LOAD - LBS.	220	190	210	210	210	210
TARE NO.	A.3	V.33	V.26	A.17	V.85	V.70
WT. WET SOIL + TARE	117.78	136.60	124.99	129.62	141.93	111.73
WT. DRY SOIL + TARE	107.40	125.61	114.98	119.14	130.98	102.52
WT. OF MOISTURE	10.38	11.09	10.01	10.48	10.95	9.21
WT. OF TARE	58.85	75.18	68.50	70.19	80.28	59.97
WT. DRY SOIL	48.55	50.43	46.48	48.95	50.70	42.55
SOAKED MOIST. CONT. %	21.4	22.0	21.6	21.5	21.6	21.6
SOAKED DIAL HEIGHT	.480	.489	.490	.483	.493	.500

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	5P
Optimum Moisture Content	22.0 %	Lime-Pozzolan Ratio	7:3
Wt. Lime [21 %]	294 gm.	Percent Additive	30
Wt. Pozzolan [9 %]	126 gm.	Date Constructed	7-2-61
Wt. Soil	980 gm.	Date Broken	8-3-61
Wt. Dry Mix	1400 gm.	Results	
Wt. Water	308 gm.	Aver. Dry Unit Wt. - pcf	95.2
Moulding Moisture Content		Aver. Unconf. Load - lbs.	260
Container No.	J.194	Aver. Unconf. Press. - psi	83
Wt. Wet Soil + Tare	134.50 gm.	Aver. Soaked Moist. - %	23.7
Wt. Dry Soil + Tare	115.39 gm.	Vol. of Lime - cf	.142
Wt. Moisture	19.11 gm.	Vol. of Pozzolan - cf	.050
Wt. Tare	30.20 gm.	Vol. of Soil - cf	.389
Wt. Dry Soil	85.19 gm.	Vol. of Water - cf	.342
Moisture Content	22.4 %	Vol. of Solids - cf	.581

Sample No.	11	12	13	14	15	16
Height Dial - .0001	.515	503	.505	.499	.502	.501
Sample Height - inch	2.015	2.003	2.005	1.999	2.002	2.001
Wt. Wet Sample - gm.	194.18	193.17	193.15	193.27	192.82	192.98
Dry Unit Wt. - pcf	95.1	95.2	95.1	95.4	95.1	95.2
Proving Dial - 0.0001	34	34	35	34	34	35
Unconf. Load - lbs.	260	260	270	260	260	270
Tare No.	H.24	H.50	H.42	H.46	H.54	H.21
Wt. Wet Soil + Tare	117.72	129.72	128.55	110.58	130.73	138.70
Wt. Dry Soil + Tare	102.80	112.40	111.79	96.95	113.50	119.97
Wt. of Moisture	14.92	17.32	16.76	13.63	17.23	18.73
Wt. of Tare	39.90	39.29	41.32	38.99	40.13	40.62
Wt. Dry Soil	62.90	73.11	70.47	57.96	73.37	79.35
Soaked Moist. Cont. %	23.8	23.7	23.8	23.6	23.6	23.6
Soaked Dial Height	.515	.505	.506	.500	.497	.497

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LIME POZZOLAN SOIL STABILIZATION

Optimum Moisture Content	23.6 %	Series No.	5Q
Wt. Lime [28 %]	392 gm.	Lime-Pozzolan Ratio	7:3
Wt. Pozzolan [12 %]	168 gm.	Percent Additive	40
Wt. Soil	840 gm.	Date Constructed	7.2.61
Wt. Dry Mix	1400 gm.	Date Broken	8.3.61
Wt. Water	330 gm.	**Results**	
Moulding Moisture Content		Aver. Dry Unit Wt. - pcf	91.6
Container No.	J.195	Aver. Unconf. Load - lbs.	330
Wt. Wet Soil + Tare	175.62 gm.	Aver. Unconf. Press. - psi	105
Wt. Dry Soil + Tare	149.53 gm.	Aver. Soaked Moist. - %	25.4
Wt. Moisture	26.09 gm.	Vol. of Lime - cf	.182
Wt. Tare	39.02 gm.	Vol. of Pozzolan - cf	.064
Wt. Dry Soil	110.51 gm.	Vol. of Soil - cf	.321
Moisture Content	23.6 %	Vol. of Water - cf	.346
		Vol. of Solids - cf	.567

Sample No.	L1	12	13	14	15	16
Height Dial - .0001	.513	.502	.506	.508	.510	.518
Sample Height - inch	2.013	2.002	2.006	2.008	2.010	2.018
Wt. Wet Sample - gm.	187.87	187.68	187.60	187.66	188.40	187.89
Dry Unit Wt. - pcf	91.4	91.8	91.8	91.6	91.9	91.3
Proving Dial - 0.0001	41	44	45	43	41	44
Unconf. Load - lbs.	310	340	340	330	310	340
Tare No.	H.45	H.4	H.28	H.36	H.26	H.33
Wt. Wet Soil + Tare	120.32	111.34	125.04	114.25	119.59	118.51
Wt. Dry Soil + Tare	105.72	96.70	107.69	99.56	103.52	102.76
Wt. of Moisture	14.60	14.64	17.35	14.69	16.07	15.75
Wt. of Tare	47.91	38.82	40.43	40.90	40.85	40.93
Wt. Dry Soil	57.81	57.88	67.26	58.66	62.67	61.83
Soaked Moist. Cont. %	25.3	25.3	25.8	25.0	25.6	25.5
Soaked Dial Height	.508	.503	.513	.510	.510	.515

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LIME POZZOLAN SOIL STABILIZATION

		SERIES NO.	5R
OPTIMUM MOISTURE CONTENT	22.7 %	LIME-POZZOLAN RATIO	9:1
WT. LIME [27 %]	378 GM.	PERCENT ADDITIVE	30
WT. POZZOLAN [3 %]	42 GM.	DATE CONSTRUCTED	2.2.61
WT. SOIL	980 GM.	DATE BROKEN	3.3.61
WT. DRY MIX	1400 GM.	RESULTS	
WT. WATER	318 GM.	AVER. DRY UNIT WT. - PCF	92.8
MOULDING MOISTURE CONTENT		AVER. UNCONF. LOAD - LBS.	240
CONTAINER NO.	J.152	AVER. UNCONF. PRESS. - PSI	76
WT. WET SOIL + TARE	132.60 GM.	AVER. SOAKED MOIST. - %	23.9
WT. DRY SOIL + TARE	113.49 GM.	VOL. OF LIME - CF	.199
WT. MOISTURE	19.11 GM.	VOL. OF POZZOLAN - CF	016
WT. TARE	30.60 GM.	VOL. OF SOIL - CF	363
WT. DRY SOIL	82.89 GM.	VOL. OF WATER - CF	.343
MOISTURE CONTENT	23.0 %	VOL. OF SOLIDS - CF	578

SAMPLE NO.	1	2	3	4	5	6
HEIGHT DIAL - .0001	.490	.492	.494	.489	.490	.502
SAMPLE HEIGHT - INCH	1.990	1.992	1.994	1.989	1990	2.002
WT. WET SAMPLE - GM.	188.10	188.01	188.47	188.22	187.62	188.48
DRY UNIT WT. - PCF	92.9	92.8	92.8	93.1	92.8	92.6
PROVING DIAL - 0.0001	33	33	32	31	33	31
UNCONF. LOAD - LBS.	250	250	240	240	250	240
TARE NO.	V.68	Y31.15	V.59	V.66	V.82	V.65
WT. WET SOIL + TARE	131.52	117.72	223.17	128.84	113.19	119.18
WT. DRY SOIL + TARE	118.70	106.89	111.74	116.82	103.00	108.69
WT. OF MOISTURE	12.82	10.83	11.43	12.02	10.19	10.49
WT. OF TARE	65.25	61.32	64.04	66.30	60.05	64.68
WT. DRY SOIL	53.45	45.57	47.70	50.52	42.95	44.01
SOAKED MOIST. CONT. %	24.1	23.8	24.0	23.8	23.8	23.8
SOAKED DIAL HEIGHT	.492	.489	.486	.486	.484	.500

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LIME POZZOLAN SOIL STABILIZATION

Optimum Moisture Content	21.4 %	Series No.	55
Wt. Lime [20 %]	280 gm.	Lime-Pozzolan Ratio	20:3
Wt. Pozzolan [3 %]	42 gm.	Percent Additive	23
Wt. Soil	1078 gm.	Date Constructed	2·2·61
Wt. Dry Mix	1400 gm.	Date Broken	3·3·61
Wt. Water	299 gm.	**Results**	
Moulding Moisture Content		Aver. Dry Unit Wt. - pcf	96.3
Container No.	J·155	Aver. Unconf. Load - lbs.	230
Wt. Wet Soil + Tare	161.41 gm.	Aver. Unconf. Press. - psi	73
Wt. Dry Soil + Tare	137.59 gm.	Aver. Soaked Moist. - %	22.6
Wt. Moisture	23.82 gm.	Vol. of Lime - cf	.137
Wt. Tare	29.42 gm.	Vol. of Pozzolan - cf	.017
Wt. Dry Soil	108.17 gm.	Vol. of Soil - cf	.433
Moisture Content	22.0 %	Vol. of Water - cf	.340
		Vol. of Solids - cf	.587

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.532	.511	505	.521	.517	526
Sample Height - inch	2.032	2.011	2.005	2.021	2.017	2.026
Wt. Wet Sample - gm.	197.90	195.84	195.20	196.49	196.13	196.15
Dry Unit Wt. - pcf	96.7	96.5	96.6	96.3	96.0	95.5
Proving Dial - 0.0001	29	31	29	30	31	27
Unconf. Load - lbs.	220	240	220	230	240	200
Tare No.	V·44	V 81·64	V·52	V 57·10	A·24	A·26·2
Wt. Wet Soil + Tare	123.91	117.11	129.51	132.33	123.66	117.12
Wt. Dry Soil + Tare	111.87	107.78	118.64	121.19	111.88	106.43
Wt. of Moisture	12.04	9.33	10.87	11.14	11.78	10.69
Wt. of Tare	58.41	66.41	70.55	71.51	59.97	59.40
Wt. Dry Soil	53.46	41.37	48.09	49.68	51.91	47.03
Soaked Moist. Cont. %	22.6	22.6	22.6	22.4	22.7	22.7
Soaked Dial Height	.528	.510	.499	.516	.518	.523

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	5T
Optimum Moisture Content	19.0 %	Lime-Pozzolan Ratio	10:3
Wt. Lime [10 %]	140 gm.	Percent Additive	13
Wt. Pozzolan [3 %]	42 gm.	Date Constructed	2.2.61
Wt. Soil	1218 gm.	Date Broken	3.3.61
Wt. Dry Mix	1400 gm.	Results	
Wt. Water	266 gm.	Aver. Dry Unit Wt. - pcf	100.3
Moulding Moisture Content		Aver. Unconf. Load - lbs.	190
Container No.	J.154	Aver. Unconf. Press. - psi	60
Wt. Wet Soil + Tare	152.60 gm.	Aver. Soaked Moist. - %	21.5
Wt. Dry Soil + Tare	132.32 gm.	Vol. of Lime - cf	.071
Wt. Moisture	20.28 gm.	Vol. of Pozzolan - cf	.018
Wt. Tare	30.48 gm.	Vol. of Soil - cf	.510
Wt. Dry Soil	101.84 gm.	Vol. of Water - cf	.322
Moisture Content	20.0 %	Vol. of Solids - cf	.599

Sample No:	1	2	3	4	5	6
Height Dial - .0001	.505	513	512	.516	.525	.517
Sample Height - inch	2.005	2.013	2.012	2.016	2.025	2.017
Wt. Wet Sample - gm.	199.75	200.23	200.32	200.19	200.30	200.31
Dry Unit Wt. - pcf	100.3	100.4	100.4	100.3	100.3	100.2
					∇	
Proving Dial - 0.0001	26	26	26	26	23	24
Unconf. Load - lbs.	200	200	200	200	170	180
Tare No.	A.17	V.26	A.20	V.33	V.63	V.18
Wt. Wet Soil + Tare	141.02	128.17	127.98	138.14	129.73	121.87
Wt. Dry Soil + Tare	128.66	117.89	117.36	127.12	117.81	111.07
Wt. of Moisture	12.36	10.28	10.62	11.02	11.92	10.80
Wt. of Tare	70.19	68.50	66.37	75.18	66.72	60.32
Wt. Dry Soil	58.47	49.39	50.99	51.94	51.09	50.75
Soaked Moist. Cont. %	21.2	20.9	20.9	21.2	23.3	21.3
Soaked Dial Height	.506	.506	508	.510	.523	.513

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	5U
Optimum Moisture Content	17.8 %	Lime-Pozzolan Ratio	5:0
Wt. Lime [5 %]	70 gm.	Percent Additive	5
Wt. Pozzolan [0 %]	0 gm.	Date Constructed	3·2·61
Wt. Soil	1330 gm.	Date Broken	4·3·61
Wt. Dry Mix	1400 gm.	**Results**	
Wt. Water	249 gm.	Aver. Dry Unit Wt. - pcf	104.2
Moulding Moisture Content		Aver. Unconf. Load - lbs.	210
Container No.	J·157	Aver. Unconf. Press. - psi	67
Wt. Wet Soil + Tare	164.62 gm.	Aver. Soaked Moist. - %	19.2
Wt. Dry Soil + Tare	144.00 gm.	Vol. of Lime - cf	.022
Wt. Moisture	20.62 gm.	Vol. of Pozzolan - cf	—
Wt. Tare	30.42 gm.	Vol. of Soil - cf	.591
Wt. Dry Soil	113.58 gm.	Vol. of Water - cf	.304
Moisture Content	18.2 %	Vol. of Solids - cf	.613

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.544	.491	.515	518	527	517
Sample Height - inch	2.044	1.991	2.015	2.018	2.027	2.017
Wt. Wet Sample - gm.	208.33	205.48	205.42	205.00	205.25	205.36
Dry Unit Wt. - pcf	104.2	105.6	104.1	103.8	103.4	104.2
Proving Dial - 0.0001	27	32	27	25	26	29
Unconf. Load - lbs.	200	240	200	190	200	220
Tare No.	A·25	Y·33	Y·63	Y·47	Y·71	A·17
Wt. Wet Soil + Tare	115.83	154.27	129.41	131.48	139.83	144.52
Wt. Dry Soil + Tare	107.00	141.81	119.20	120.50	129.32	132.50
Wt. of Moisture	8.83	12.46	10.21	10.98	10.51	12.02
Wt. of Tare	60.48	75.18	66.72	63.90	74.49	70.19
Wt. Dry Soil	46.52	66.63	52.48	56.60	54.83	62.31
Soaked Moist. Cont. %	19.0	18.7	19.5	19.4	19.2	19.3
Soaked Dial Height	.533	.485	507	515	.514	.508

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	5 V
Optimum Moisture Content	18.8 %	Lime-Pozzolan Ratio	10:0
Wt. Lime [10 %]	140 gm.	Percent Additive	10
Wt. Pozzolan [nil %]	nil gm.	Date Constructed	3·2·61
Wt. Soil	1260 gm.	Date Broken	4·3·61
Wt. Dry Mix	1400 gm.	**Results**	
Wt. Water	263 gm.	Aver. Dry Unit Wt. - pcf	101.4
Moulding Moisture Content		Aver. Unconf. Load - lbs.	170
Container No.	J.159	Aver. Unconf. Press. - psi	54
Wt. Wet Soil + Tare	155.59 gm.	Aver. Soaked Moist. - %	20.6
Wt. Dry Soil + Tare	135.59 gm.	Vol. of Lime - cf	.072
Wt. Moisture	20.00 gm.	Vol. of Pozzolan - cf	—
Wt. Tare	31.06 gm.	Vol. of Soil - cf	.533
Wt. Dry Soil	104.53 gm.	Vol. of Water - cf	.311
Moisture Content	19.1 %	Vol. of Solids - cf	.605

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.524	.512	.505	.502	.500	.511
Sample Height - inch	2.024	2.012	2.005	2.002	2.000	2.011
Wt. Wet Sample - gm.	202.25	200.42	200.28	200.48	200.20	200.29
Dry Unit Wt. - pcf	101.3	101.4	101.4	101.6	101.8	101.2
Proving Dial - 0.0001	21	22	22	23	22	22
Unconf. Load - lbs.	160	170	170	170	170	170
Tare No.	A.14.14	A.13	V.76	V.26	V.5	V.78
Wt. Wet Soil + Tare	127.85	126.39	123.87	129.42	132.20	153.06
Wt. Dry Soil + Tare	116.60	116.22	113.80	119.15	120.90	140.91
Wt. of Moisture	11.25	10.17	10.07	10.27	11.30	12.15
Wt. of Tare	62.75	66.22	64.97	68.50	65.44	82.61
Wt. Dry Soil	53.85	50.00	48.83	50.65	55.46	58.30
Soaked Moist. Cont. %	20.9	20.4	20.6	20.3	20.4	20.9
Soaked Dial Height	.520	.505	.497	.495	.490	.503

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LIME POZZOLAN SOIL STABILIZATION

Optimum Moisture Content	21.0 %	Series No.	5W
Wt. Lime [20 %]	280 gm.	Lime-Pozzolan Ratio	20:0
Wt. Pozzolan [nil %]	nil gm.	Percent Additive	20
Wt. Soil	1120 gm.	Date Constructed	3·2·61
Wt. Dry Mix	1400 gm.	Date Broken	4·3·61
Wt. Water	294 gm.	**Results**	
Moulding Moisture Content		Aver. Dry Unit Wt. - pcf	96.2
		Aver. Unconf. Load - lbs.	200
Container No.	J.161	Aver. Unconf. Press. - psi	64
Wt. Wet Soil + Tare	167.75 gm.	Aver. Soaked Moist. - %	22.8
Wt. Dry Soil + Tare	143.50 gm.	Vol. of Lime - cf	.137
Wt. Moisture	24.25 gm.	Vol. of Pozzolan - cf	—
Wt. Tare	29.93 gm.	Vol. of Soil - cf	.452
Wt. Dry Soil	113.57 gm.	Vol. of Water - cf	.333
Moisture Content	21.5 %	Vol. of Solids - cf	.589

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.530	.505	.507	.512	.503	.498
Sample Height - inch	2.030	2.005	2.007	2.012	2.003	1.998
Wt. Wet Sample - gm.	196.15	194.03	194.21	193.87	193.62	193.78
Dry Unit Wt. - pcf	96.2	96.3	96.3	96.0	96.1	96.5
Proving Dial - 0.0001	26	26	25	25	27	26
Unconf. Load - lbs.	200	200	190	190	200	200
Tare No.	138	139	140	141	142	143
Wt. Wet Soil + Tare	147.88	165.23	167.96	163.79	152.57	156.68
Wt. Dry Soil + Tare	136.62	151.00	153.26	149.78	139.60	143.40
Wt. of Moisture	11.26	14.23	14.70	14.01	12.97	13.28
Wt. of Tare	87.40	87.65	88.10	88.87	82.50	85.03
Wt. Dry Soil	49.12	63.35	65.16	60.91	57.10	58.37
Soaked Moist. Cont. %	22.9	22.6	22.6	23.0	22.7	22.8
Soaked Dial Height	.520	.494	.496	.498	.493	.491

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LIME POZZOLAN SOIL STABILIZATION

		SERIES NO.	5X
OPTIMUM MOISTURE CONTENT	16.0 %	LIME-POZZOLAN RATIO	—
WT. LIME [nil %]	nil GM.	PERCENT ADDITIVE	nil
WT. POZZOLAN [nil %]	nil GM.	DATE CONSTRUCTED	2·2·61
WT. SOIL	1500 GM.	DATE BROKEN	3·3·61
WT. DRY MIX	1500 GM.	RESULTS	
WT. WATER	240 GM.	AVER. DRY UNIT WT. - PCF	109.3
MOULDING MOISTURE CONTENT		AVER. UNCONF. LOAD - LBS. *	100
CONTAINER NO.	J.151	AVER. UNCONF. PRESS. - PSI *	32
WT. WET SOIL + TARE	164.42 GM.	AVER. SOAKED MOIST. - %	17.5
WT. DRY SOIL + TARE	143.96 GM.	VOL. OF LIME - CF	—
WT. MOISTURE	20.46 GM.	VOL. OF POZZOLAN - CF	—
WT. TARE	30.28 GM.	VOL. OF SOIL - CF	.639
WT. DRY SOIL	113.68 GM.	VOL. OF WATER - CF	316
MOISTURE CONTENT	18.0 %	VOL. OF SOLIDS - CF	.639

SAMPLE NO:	1	2	3	4	5	6
HEIGHT DIAL - .0001	.514	.522	.516	.528	.518	.516
SAMPLE HEIGHT - INCH	2.014	2.022	2.016	2.028	2.018	2.016
WT. WET SAMPLE - GM.	215.55	215.82	215.41	215.79	216.03	215.33
DRY UNIT WT. - PCF	109.7	109.2	109.0	109.0	109.9	109.2
PROVING DIAL - 0.0001	18	14	14	14	14	14
UNCONF. LOAD - LBS.	130	100	100	100	100	100
TARE NO.	V.28	V.70	A.3	V.85	V.41	A.14
WT. WET SOIL + TARE	162.04	126.80	122.90	151.48	128.20	119.66
WT. DRY SOIL + TARE	150.21	116.90	113.38	140.82	117.39	111.23
WT. OF MOISTURE	11.83	9.90	9.62	10.66	10.81	8.43
WT. OF TARE	82.58	59.97	58.85	80.28	56.10	62.75
WT. DRY SOIL	67.63	56.93	54.53	60.54	61.29	48.48
SOAKED MOIST. CONT. %	17.5	17.4	17.6	17.6	17.7	17.4
SOAKED DIAL HEIGHT	.507	.503	.507	.506	.509	.505

Samples disturbed during extrusion.

* Samples were not soaked.

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	10 A
Optimum Moisture Content	20.9 %	Lime-Pozzolan Ratio	5:5
Wt. Lime [20 %]	280 gm.	Percent Additive	40
Wt. Pozzolan [20 %]	280 gm.	Date Constructed	6·2·61
Wt. Soil	840 gm.	Date Broken	7·3·61
Wt. Dry Mix	1400 gm.	Results	
Wt. Water	292 gm.	Aver. Dry Unit Wt. - pcf	96.4
Moulding Moisture Content		Aver. Unconf. Load - lbs.	780
Container No.	J·182	Aver. Unconf. Press. - psi	248
Wt. Wet Soil + Tare	123.30 gm.	Aver. Soaked Moist. - %	23.0
Wt. Dry Soil + Tare	107.47 gm.	Vol. of Lime - cf	.137
Wt. Moisture	15.83 gm.	Vol. of Pozzolan - cf	.113
Wt. Tare	30.29 gm.	Vol. of Soil - cf	.338
Wt. Dry Soil	77.18 gm.	Vol. of Water - cf	.317
Moisture Content	20.5 %	Vol. of Solids - cf	.588

Sample No.	L1	12	13	14	15	16
Height Dial - .0001	.473	.500	.512	.500	.490	.511
Sample Height - inch	1.973	2.000	2.012	2.000	1.990	2.011
Wt. Wet Sample - gm.	189.32	192.78	192.41	191.95	191.71	192.18
Dry Unit Wt. - pcf	96.3	96.8	96.0	96.3	96.8	96.0
Proving Dial - 0.0001	98	98	98	103	101	102
Unconf. Load - lbs.	770	770	770	810	790	800
Tare No.	V·74	V·41	V·59	V·81	V·76	A·20
Wt. Wet Soil + Tare	128.83	118.67	117.82	131.30	119.03	126.25
Wt. Dry Soil + Tare	117.01	106.79	107.38	118.82	108.83	114.74
Wt. of Moisture	11.82	11.88	9.44	12.48	10.20	11.51
Wt. of Tare	66.54	56.10	64.04	66.41	61.50	66.37
Wt. Dry Soil	50.47	50.69	43.34	52.41	47.33	48.37
Soaked Moist. Cont. %	23.5	23.4	21.8	23.8	21.6	23.8
Soaked Dial Height	——	.505	.514	.502	.496	.512

LIME POZZOLAN SOIL STABILIZATION

		Series No.	10 B
Optimum Moisture Content	20.5 %	Lime-Pozzolan Ratio	3:7
Wt. Lime [12 %]	180 gm.	Percent Additive	40
Wt. Pozzolan [28 %]	420 gm.	Date Constructed	24.1.61
Wt. Soil	900 gm.	Date Broken	22.2.61
Wt. Dry Mix	1500 gm.	**Results**	
Wt. Water	307 gm.	Aver. Dry Unit Wt. - pcf	93.6
Moulding Moisture Content		Aver. Unconf. Load - lbs.	820
Container No.	J.105	Aver. Unconf. Press. - psi	261
Wt. Wet Soil + Tare	125.50 gm.	Aver. Soaked Moist. - %	25.8
Wt. Dry Soil + Tare	110.78 gm.	Vol. of Lime - cf	.080
Wt. Moisture	14.72 gm.	Vol. of Pozzolan - cf	.153
Wt. Tare	29.91 gm.	Vol. of Soil - cf	.328
Wt. Dry Soil	80.87 gm.	Vol. of Water - cf	.272
Moisture Content	18.2 %	Vol. of Solids - cf	.560

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.498	.510	.481	.497	.491	.494
Sample Height - inch	1.998	2.010	1.981	1.997	1.991	1.994
Wt. Wet Sample - gm.	183.41	183.13	182.79	183.07	183.29	183.20
Dry Unit Wt. - pcf	94.6	93.9	94.7	94.1	92.3	91.9
Proving Dial - 0.0001	100	106	105	104	108	105
Unconf. Load - lbs.	780	830	820	810	850	820
Tare No.	V.82	V.5	V.65	V.79	A.25	V.74
Wt. Wet Soil + Tare	103.51	110.16	110.67	107.70	110.97	108.26
Wt. Dry Soil + Tare	94.51	100.94	101.43	97.72	100.62	99.68
Wt. of Moisture	9.00	9.22	9.24	9.98	10.35	8.58
Wt. of Tare	60.05	65.44	64.68	59.72	60.48	66.54
Wt. Dry Soil	34.46	35.50	36.75	38.00	40.14	33.14
Soaked Moist. Cont. %	26.1	25.9	25.2	26.3	25.1	25.9
Soaked Dial Height	.513	.518	.494	.507	.503	.499

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LIME POZZOLAN SOIL STABILIZATION

		SERIES NO.	10C
OPTIMUM MOISTURE CONTENT	19.2 %	LIME-POZZOLAN RATIO	5:5
WT. LIME [15 %]	210 GM.	PERCENT ADDITIVE	30
WT. POZZOLAN [15 %]	210 GM.	DATE CONSTRUCTED	6·2·61
WT. SOIL	980 GM.	DATE BROKEN	7·3·61
WT. DRY MIX	1400 GM.	RESULTS	
WT. WATER	268 GM.	AVER. DRY UNIT WT. - PCF	99.3
MOULDING MOISTURE CONTENT		AVER. UNCONF. LOAD - LBS.	580
CONTAINER NO.	J·183	AVER. UNCONF. PRESS. - PSI	185
WT. WET SOIL + TARE	123.03 GM.	AVER. SOAKED MOIST. - %	21.6
WT. DRY SOIL + TARE	106·70 GM.	VOL. OF LIME - CF	.106
WT. MOISTURE	16·33 GM.	VOL. OF POZZOLAN - CF	·087
WT. TARE	22.48 GM.	VOL. OF SOIL - CF	.406
WT. DRY SOIL	84.22 GM.	VOL. OF WATER - CF	·309
MOISTURE CONTENT	19.4 %	VOL. OF SOLIDS - CF	.599

SAMPLE NO.	L1	12	13	14	15	16
HEIGHT DIAL - .0001	.450	.512	.515	.519	.513	.527
SAMPLE HEIGHT - INCH	1.950	2.012	2.015	2.019	2.013	2.027
WT. WET SAMPLE - GM.	192.61	197.40	197.68	197.85	197.25	197.63
DRY UNIT WT. - PCF	100·0	99.4	99.2	99.2	99.2	98.7
PROVING DIAL - 0.0001	77	77	75	74	71	72
UNCONF. LOAD - LBS.	600	600	580	570	550	560
TARE NO.	V·18	A·14	V·71	V 59116	A·3	V·65
WT. WET SOIL + TARE	114·69	120.70	142.29	134.66	122.65	135.58
WT. DRY SOIL + TARE	104.97	110·42	130.22	122.60	111·29	122.92
WT. OF MOISTURE	9.62	10.28	12.07	12.06	11.36	12.66
WT. OF TARE	60.32	62.80	74.49	66.60	58.85	64.68
WT. DRY SOIL	44.65	47.62	55.73	56.00	52.44	58.24
SOAKED MOIST. CONT. %	21.5	21.6	21.6	21.5	21.7	21.7
SOAKED DIAL HEIGHT	.453	·508	·515	.517	.515	.525

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	10 D
Optimum Moisture Content	17.5 %	Lime-Pozzolan Ratio	5:5
Wt. Lime [10 %]	140 gm.	Percent Additive	20
Wt. Pozzolan [10 %]	140 gm.	Date Constructed	6·2·61
Wt. Soil	1120 gm.	Date Broken	7·3·61
Wt. Dry Mix	1400 gm.	Results	
Wt. Water	245 gm.	Aver. Dry Unit Wt. - pcf	102.2
Moulding Moisture Content		Aver. Unconf. Load - lbs.	420
Container No.	J·184	Aver. Unconf. Press. - psi	130
Wt. Wet Soil + Tare	143.49 gm.	Aver. Soaked Moist. - %	20.0
Wt. Dry Soil + Tare	126.40 gm.	Vol. of Lime - cf	·073
Wt. Moisture	17.09 gm.	Vol. of Pozzolan - cf	·060
Wt. Tare	30.50 gm.	Vol. of Soil - cf	.478
Wt. Dry Soil	95.90 gm.	Vol. of Water - cf	·292
Moisture Content	17.8 %	Vol. of Solids - cf	·611

Sample No.	L1	12	13	14	15	16
Height Dial - .0001	.489	.524	.528	.517	.511	.519
Sample Height - inch	1.989	2.024	2.028	2.017	2.011	2.019
Wt. Wet Sample - gm.	199.40	200.70	200.82	200.53	200.61	200.47
Dry Unit Wt. - pcf	103.0	101.8	101.7	102.2	102.4	102.2
Proving Dial - 0.0001	57	55	55	56	56	54
Unconf. Load - lbs.	440	420	420	430	430	410
Tare No.	V·26	V·47	V·5	V·49	V·66	A·13
Wt. Wet Soil + Tare	133.14	133.88	121.70	134.35	141.92	133.50
Wt. Dry Soil + Tare	122.32	122.11	112.23	122.52	129.48	122.29
Wt. of Moisture	10.82	11.47	9.47	11.83	12.44	11.22
Wt. of Tare	68.50	63.90	65.44	62.90	66.30	66.22
Wt. Dry Soil	54.82	58.21	46.79	59.62	63.18	56.07
Soaked Moist. Cont. %	19.8	20.2	20.2	19.8	19.7	20.0
Soaked Dial Height	.491	·520	.530	.512	.510	.518

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LIME POZZOLAN SOIL STABILIZATION

Optimum Moisture Content	15.8 %	Series No.	10 E
Wt. Lime [5 %]	70 gm.	Lime-Pozzolan Ratio	5:5
Wt. Pozzolan [5 %]	70 gm.	Percent Additive	10
Wt. Soil	1260 gm.	Date Constructed	25·1·61
Wt. Dry Mix	1400 gm.	Date Broken	23·2·61
Wt. Water	221 gm.	**Results**	
Moulding Moisture Content		Aver. Dry Unit Wt. - pcf	103.8
Container No.	J·114	Aver. Unconf. Load - lbs.	310
Wt. Wet Soil + Tare	144.55 gm.	Aver. Unconf. Press. - psi	99
Wt. Dry Soil + Tare	129.63 gm.	Aver. Soaked Moist. - %	18.8
Wt. Moisture	14.92 gm.	Vol. of Lime - cf	·037
Wt. Tare	29.44 gm.	Vol. of Pozzolan - cf	·030
Wt. Dry Soil	100.19 gm.	Vol. of Soil - cf	·546
Moisture Content	14.9 %	Vol. of Water - cf	·248
		Vol. of Solids - cf	·613

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.413	.505	.500	.494	.497	.506
Sample Height - inch	1.913	2.005	2.000	1.994	1.997	2.006
Wt. Wet Sample - gm.	195.51	197.59	197.40	197.52	197.83	197.84
Dry Unit Wt. - pcf	104.3	103.7	104.00	103.1	104.2	103.7
Proving Dial - 0.0001	41	39	39	41	41	41
Unconf. Load - lbs.	310	300	300	310	310	310
Tare No.	V·28	V·63	A·27	A·14	V·85	V·65
Wt. Wet Soil + Tare	128.80	120.96	120.56	116.73	139.72	123.18
Wt. Dry Soil + Tare	121.44	112.37	111.08	108.27	130.23	114.10
Wt. of Moisture	7.36	8.59	9.48	8.46	9.49	9.08
Wt. of Tare	82.58	66.72	61.35	62.80	80.28	64.68
Wt. Dry Soil	38.86	45.65	49.73	45.47	49.95	49.42
Soaked Moist. Cont. %	18.9	18.8	19.1	18.6	19.0	18.4
Soaked Dial Height	.476	.508	.508	.501	.503	.512

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		Series No.	10F
Optimum Moisture Content	15.2 %	Lime-Pozzolan Ratio	5:5
Wt. Lime [3 %]	42 gm.	Percent Additive	6
Wt. Pozzolan [3 %]	42 gm.	Date Constructed	26.1.61
Wt. Soil	1316 gm.	Date Broken	24.2.61
Wt. Dry Mix	1400 gm.	**Results**	
Wt. Water	213 gm.	Aver. Dry Unit Wt. - pcf	106.2
Moulding Moisture Content		Aver. Unconf. Load - lbs.	310
Container No.	J.117	Aver. Unconf. Press. - psi	99
Wt. Wet Soil + Tare	149.00 gm.	Aver. Soaked Moist. - %	18.0
Wt. Dry Soil + Tare	133.52 gm.	Vol. of Lime - cf	.023
Wt. Moisture	15.48 gm.	Vol. of Pozzolan - cf	.019
Wt. Tare	30.41 gm.	Vol. of Soil - cf	.583
Wt. Dry Soil	103.11 gm.	Vol. of Water - cf	.254
Moisture Content	15.0 %	Vol. of Solids - cf	.625

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.458	.537	515	.500	.524	.524
Sample Height - inch	1.958	2.037	2.015	2.000	2.024	2.024
Wt. Wet Sample - gm.	199.83	205.62	203.42	203.28	203.59	203.11
Dry Unit Wt. - pcf	107.2	106.2	106.2	106.9	105.8	105.3
Proving Dial - 0.0001	46	41	40	44	38	36
Unconf. Load - lbs.	350	310	300	330	290	270
Tare No.	V.47	V.74	A.20	V.70	V.33	V81.64
Wt. Wet Soil + Tare	117.46	122.32	115.38	111.53	128.59	133.10
Wt. Dry Soil + Tare	109.30	113.78	108.02	103.80	120.48	122.65
Wt. of Moisture	8.16	8.54	7.36	7.73	8.11	10.45
Wt. of Tare	63.90	66.54	66.37	59.97	75.18	66.41
Wt. Dry Soil	45.40	47.24	41.65	43.83	45.30	56.24
Soaked Moist. Cont. %	18.0	18.1	17.7	17.6	17.9	18.6
Soaked Dial Height	.458	.529	.518	.503	.529	.529

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	10G
Optimum Moisture Content	19.0 %	Lime-Pozzolan Ratio	3:7
Wt. Lime [9 %]	126 gm.	Percent Additive	30
Wt. Pozzolan [21 %]	294 gm.	Date Constructed	26.1.61
Wt. Soil	980 gm.	Date Broken	24.2.61
Wt. Dry Mix	1400 gm.	Results	
Wt. Water	266 gm.	Aver. Dry Unit Wt. - pcf	98.6
Moulding Moisture Content		Aver. Unconf. Load - lbs.	700
Container No.	J.120	Aver. Unconf. Press. - psi	223
Wt. Wet Soil + Tare	141.67 gm.	Aver. Soaked Moist. - %	22.4
Wt. Dry Soil + Tare	125.72 gm.	Vol. of Lime - cf	.063
Wt. Moisture	15.95 gm.	Vol. of Pozzolan - cf	.121
Wt. Tare	31.21 gm.	Vol. of Soil - cf	.403
Wt. Dry Soil	94.51 gm.	Vol. of Water - cf	.278
Moisture Content	16.9 %	Vol. of Solids - cf	.587

Sample No.	1	2	3	4	5	6
Height Dial - .0001	507	.507	.498	.501	.493	.500
Sample Height - inch	2.007	2.007	1.998	2.001	1.993	2.000
Wt. Wet Sample - gm.	191.00	190.90	190.43	190.17	190.31	191.14
Dry Unit Wt. - pcf	98.4	98.4	98.7	98.4	98.9	98.9
Proving Dial - 0.0001	92	89	90	92	90	89
Unconf. Load - lbs.	720	690	700	720	700	690
Tare No.	V.68	V.76	V.52	V.59.16	V.57.10	A26.2
Wt. Wet Soil + Tare	123.03	112.19	124.62	119.19	112.73	106.01
Wt. Dry Soil + Tare	112.23	103.30	114.65	109.40	105.22	97.40
Wt. of Moisture	10.80	8.89	9.97	9.79	7.51	8.61
Wt. of Tare	65.25	61.50	70.55	66.60	71.51	59.40
Wt. Dry Soil	46.98	41.80	44.10	42.80	33.71	38.00
Soaked Moist. Cont. %	23.0	21.2	22.6	22.9	22.2	22.6
Soaked Dial Height	.514	.516	.508	.514	.501	.511

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	10H
Optimum Moisture Content	17.2 %	Lime-Pozzolan Ratio	3:7
Wt. Lime [6 %]	84 gm.	Percent Additive	20
Wt. Pozzolan [14 %]	196 gm.	Date Constructed	27.1.61
Wt. Soil	1120 gm.	Date Broken	25.2.61
Wt. Dry Mix	1400 gm.	**Results**	
Wt. Water	249 gm.	Aver. Dry Unit Wt. - pcf	102.1
Moulding Moisture Content		Aver. Unconf. Load - lbs.	490
Container No.	J.123	Aver. Unconf. Press. - psi	156
Wt. Wet Soil + Tare	137.41 gm.	Aver. Soaked Moist. - %	20.6
Wt. Dry Soil + Tare	122.66 gm.	Vol. of Lime - cf	.043
Wt. Moisture	14.75 gm.	Vol. of Pozzolan - cf	.084
Wt. Tare	29.97 gm.	Vol. of Soil - cf	.477
Wt. Dry Soil	92.69 gm.	Vol. of Water - cf	.260
Moisture Content	15.9 %	Vol. of Solids - cf	.604

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.494	.487	.494	.489	.504	.491
Sample Height - inch	1.994	1.987	1.994	1.989	2.004	1.991
Wt. Wet Sample - gm.	195.15	194.90	193.84	194.67	195.16	194.53
Dry Unit Wt. - pcf	102.3	102.4	101.6	102.2	101.8	102.2
Proving Dial - 0.0001	67	65	57	67	63	61
Unconf. Load - lbs.	520	500	440	520	490	470
Tare No.	A.20	V.79	V.82	V.66	V.63	V.14
Wt. Wet Soil + Tare	133.95	127.12	120.22	134.40	123.78	131.96
Wt. Dry Soil + Tare	122.50	115.72	109.98	122.68	114.02	120.08
Wt. of Moisture	11.45	11.40	10.24	11.72	9.76	11.88
Wt. of Tare	66.37	59.72	60.05	66.30	66.72	62.75
Wt. Dry Soil	56.13	56.00	49.93	56.38	47.30	57.33
Soaked Moist. Cont. %	20.4	20.3	20.5	20.8	20.6	20.7
Soaked Dial Height	.496	.492	.497	.496	.510	.498

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	10J
Optimum Moisture Content	15.7 %	Lime-Pozzolan Ratio	3:7
Wt. Lime [3 %]	42 gm.	Percent Additive	10
Wt. Pozzolan [7 %]	98 gm.	Date Constructed	27·1·61
Wt. Soil	1260 gm.	Date Broken	25·2·61
Wt. Dry Mix	1400 gm.	**Results**	
Wt. Water	220 gm.	Aver. Dry Unit Wt. - pcf	104.4
Moulding Moisture Content		Aver. Unconf. Load - lbs.	360
Container No.	J.126	Aver. Unconf. Press. - psi	115
Wt. Wet Soil + Tare	149.87 gm.	Aver. Soaked Moist. - %	19.3
Wt. Dry Soil + Tare	133.84 gm.	Vol. of Lime - cf	.023
Wt. Moisture	16.03 gm.	Vol. of Pozzolan - cf	.043
Wt. Tare	30.48 gm.	Vol. of Soil - cf	.552
Wt. Dry Soil	103.36 gm.	Vol. of Water - cf	.261
Moisture Content	15.5 %	Vol. of Solids - cf	.618

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.458	.491	.501	.502	.501	.524
Sample Height - inch	1.958	1.991	2.001	2.002	2.001	2.024
Wt. Wet Sample - gm.	197.21	200.73	200.78	200.77	200.68	200.33
Dry Unit Wt. - pcf	105.3	105.4	105.1	105.0	104.9	103.7
Proving Dial - 0.0001	48	44	50	46	49	49
Unconf. Load - lbs.	370	340	380	350	370	370
			▽			
Tare No.	H.7	H.8	H.9	H.10	H.11	H.12
Wt. Wet Soil + Tare	104.00	137.62	146.75	112.30	146.00	111.38
Wt. Dry Soil + Tare	94.00	121.95	128.18	100.88	129.22	99.95
Wt. of Moisture	10.00	15.67	18.57	11.42	16.78	11.43
Wt. of Tare	40.73	40.55	40.28	39.30	40.90	40.36
Wt. Dry Soil	53.27	81.40	87.90	61.58	88.32	59.57
Soaked Moist. Cont. %	18.8	19.2	* 21.2	18.5	19.0	19.2
Soaked Dial Height	.464	.498	.507	.503	.511	.520

▽ Sample Soaked During Curing Period

* Not Used in Average.

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LIME POZZOLAN SOIL STABILIZATION 208

Optimum Moisture Content	20.2 %	Series No.	10 K
Wt. Lime [4 %]	56 gm.	Lime-Pozzolan Ratio	1:9
Wt. Pozzolan [36 %]	506 gm.	Percent Additive	40
Wt. Soil	838 gm.	Date Constructed	27 · 1 · 61
Wt. Dry Mix	1400 gm.	Date Broken	25 · 2 · 61
Wt. Water	283 gm.	**Results**	
Moulding Moisture Content		Aver. Dry Unit Wt. - pcf	96.2
Container No.	J.129	Aver. Unconf. Load - lbs.	1040
Wt. Wet Soil + Tare	126.30 gm.	Aver. Unconf. Press. - psi	331
Wt. Dry Soil + Tare	110.68 gm.	Aver. Soaked Moist. - %	25.2
Wt. Moisture	15.62 gm.	Vol. of Lime - cf	.027
Wt. Tare	29.42 gm.	Vol. of Pozzolan - cf	.202
Wt. Dry Soil	81.26 gm.	Vol. of Soil - cf	.338
Moisture Content	19.2 %	Vol. of Water - cf	.296
		Vol. of Solids - cf	.567

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.528	.516	.496	.512	.519	.517
Sample Height - inch	2.028	2.016	1.996	2.012	2.019	2.017
Wt. Wet Sample - gm.	192.77	191.42	189.48	191.26	190.23	190.88
Dry Unit Wt. - pcf	96.4	96.3	96.3	96.6	95.7	96.0
Proving Dial - 0.0001	124	142	133	132	124	136
Unconf. Load - lbs.	970	1120	1050	1040	970	1070
Tare No.	H.1	H.2	H.3	H.4	H.5	H.6
Wt. Wet Soil + Tare	134.28	130.50	131.70	173.82	142.76	114.75
Wt. Dry Soil + Tare	115.75	112.69	115.30	146.73	121.51	99.90
Wt. of Moisture	18.53	17.81	16.40	27.09	21.25	14.85
Wt. of Tare	40.32	41.55	50.40	40.25	39.86	40.69
Wt. Dry Soil	75.43	71.14	64.90	106.48	81.65	59.21
Soaked Moist. Cont. %	24.6	25.0	25.3	25.4	26.0	25.0
Soaked Dial Height	.540	.528	.509	.527	.529	.528

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	10 L
Optimum Moisture Content	18.8 %	Lime-Pozzolan Ratio	1:9
Wt. Lime [3 %]	42 gm.	Percent Additive	30
Wt. Pozzolan [27 %]	378 gm.	Date Constructed	30.1.61
Wt. Soil	980 gm.	Date Broken	28.2.61
Wt. Dry Mix	1400 gm.	**Results**	
Wt. Water	263 gm.	Aver. Dry Unit Wt. - pcf	99.2
Moulding Moisture Content		Aver. Unconf. Load - lbs.	770
Container No.	J.132	Aver. Unconf. Press. - psi	245
Wt. Wet Soil + Tare	145.13 gm.	Aver. Soaked Moist. - %	23.1
Wt. Dry Soil + Tare	128.08 gm.	Vol. of Lime - cf	.021
Wt. Moisture	17.05 gm.	Vol. of Pozzolan - cf	.157
Wt. Tare	31.73 gm.	Vol. of Soil - cf	.405
Wt. Dry Soil	96.35 gm.	Vol. of Water - cf	.280
Moisture Content	17.7 %	Vol. of Solids - cf	.583

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.504	.516	.521	.529	.520	.513
Sample Height - inch	2.004	2.016	2.021	2.029	2.020	2.013
Wt. Wet Sample - gm.	194.22	194.98	194.77	194.42	194.03	194.44
Dry Unit Wt. - pcf	99.5	99.6	99.1	98.6	98.8	99.3
Proving Dial - 0.0001	101	99	103	95	95	100
Unconf. Load - lbs.	790	770	810	740	740	780
Tare No.	A.24	V.71	V.47	V.78	V.68	A.13
Wt. Wet Soil + Tare	108.61	133.20	116.35	135.58	116.07	109.93
Wt. Dry Soil + Tare	99.42	122.28	106.52	125.60	106.54	101.72
Wt. of Moisture	9.19	10.92	9.83	9.98	9.53	8.21
Wt. of Tare	59.97	74.49	63.90	82.61	65.25	66.22
Wt. Dry Soil	39.45	47.79	42.62	42.99	41.29	35.50
Soaked Moist. Cont. %	23.2	22.8	23.0	23.2	23.1	23.1
Soaked Dial Height	.515	.521	.525	.529	.517	.520

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	10 M
Optimum Moisture Content	15.7 %	Lime-Pozzolan Ratio	7:3
Wt. Lime [7 %]	98 gm.	Percent Additive	10
Wt. Pozzolan [3 %]	42 gm.	Date Constructed	30.1.61
Wt. Soil	1260 gm.	Date Broken	28.2.61
Wt. Dry Mix	1400 gm.	**Results**	
Wt. Water	220 gm.	Aver. Dry Unit Wt. - pcf	103.7
Moulding Moisture Content		Aver. Unconf. Load - lbs.	290
Container No.	J.136	Aver. Unconf. Press. - psi	92
Wt. Wet Soil + Tare	149.69 gm.	Aver. Soaked Moist. - %	17.9
Wt. Dry Soil + Tare	134.42 gm.	Vol. of Lime - cf	.052
Wt. Moisture	15.27 gm.	Vol. of Pozzolan - cf	.018
Wt. Tare	29.98 gm.	Vol. of Soil - cf	.545
Wt. Dry Soil	104.44 gm.	Vol. of Water - cf	.242
Moisture Content	14.6 %	Vol. of Solids - cf	.615

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.483	.493	.484	.509	.510	.516
Sample Height - inch	1.983	1.993	1.984	2.009	2.010	2.016
Wt. Wet Sample - gm.	196.10	196.00	195.39	197.14	196.31	197.03
Dry Unit Wt. - pcf	104.4	103.8	103.9	103.5	103.1	103.2
Proving Dial - 0.0001	40	40	37	38	35	37
Unconf. Load - lbs.	300	300	280	290	270	280
Tare No.	V.59	A.27	V.59.16	V.66	A14-2	V.63
Wt. Wet Soil + Tare	121.67	119.84	125.04	135.67	120.09	129.47
Wt. Dry Soil + Tare	113.18	110.70	115.83	125.00	111.70	120.00
Wt. of Moisture	8.49	9.14	9.21	10.67	8.39	9.47
Wt. of Tare	64.04	61.35	66.60	66.30	62.80	66.72
Wt. Dry Soil	49.14	49.35	49.23	58.70	48.90	53.28
Soaked Moist. Cont. %	17.3	18.5	18.7	18.2	17.2	17.8
Soaked Dial Height	.482	.488	.479	.508	.509	.515

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	10N
Optimum Moisture Content	17.8 %	Lime-Pozzolan Ratio	7:3
Wt. Lime [14 %]	196 gm.	Percent Additive	20
Wt. Pozzolan [6 %]	84 gm.	Date Constructed	6·2·61
Wt. Soil	1120 gm.	Date Broken	7·3·61
Wt. Dry Mix	1400 gm.	**Results**	
Wt. Water	249 gm.	Aver. Dry Unit Wt. - pcf	101.7
Moulding Moisture Content		Aver. Unconf. Load - lbs.	360
Container No.	J.185	Aver. Unconf. Press. - psi	115
Wt. Wet Soil + Tare	154.62 gm.	Aver. Soaked Moist. - %	19.8
Wt. Dry Soil + Tare	135.32 gm.	Vol. of Lime - cf	.101
Wt. Moisture	19.30 gm.	Vol. of Pozzolan - cf	.036
Wt. Tare	29.93 gm.	Vol. of Soil - cf	476
Wt. Dry Soil	105.39 gm.	Vol. of Water - cf	.298
Moisture Content	18.3 %	Vol. of Solids - cf	.613

Sample No.	L1	12	13	14	15	16
Height Dial - .0001	.490	.503	.494	.501	.499	.511
Sample Height - inch	1.990	2.003	1.994	2.001	1.999	2.011
Wt. Wet Sample - gm.	198.41	199.00	198.88	198.97	199.03	199.61
Dry Unit Wt. - pcf	102.0	101.3	102.0	101.7	101.7	101.4
Proving Dial - 0.0001	50	47	48	49	48	45
Unconf. Load - lbs.	380	360	370	370	370	340
Tare No.	V.33	A.18	A.25	V.76	A.26.2	V.52
Wt. Wet Soil + Tare	153.10	139.98	126.11	123.78	121.91	139.70
Wt. Dry Soil + Tare	140.04	127.96	115.28	113.59	111.56	128.29
Wt. of Moisture	13.06	12.02	10.83	10.19	10.35	11.41
Wt. of Tare	75.18	66.42	60.48	61.50	59.40	70.55
Wt. Dry Soil	64.86	61.54	54.80	52.09	52.16	57.74
Soaked Moist. Cont. %	20.1	19.5	19.8	19.5	19.8	19.8
Soaked Dial Height	.487	.504	.494	.498	.496	.507

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	10P
Optimum Moisture Content	19.5 %	Lime-Pozzolan Ratio	7:3
Wt. Lime [21 %]	294 gm.	Percent Additive	30
Wt. Pozzolan [9 %]	126 gm.	Date Constructed	7·2·61
Wt. Soil	980 gm.	Date Broken	8·3·61
Wt. Dry Mix	1400 gm.	Results	
Wt. Water	273 gm.	Aver. Dry Unit Wt. - pcf	97.5
Moulding Moisture Content		Aver. Unconf. Load - lbs.	430
Container No.	J.189	Aver. Unconf. Press. - psi	137
Wt. Wet Soil + Tare	210.58 gm.	Aver. Soaked Moist. - %	21.2
Wt. Dry Soil + Tare	180.34 gm.	Vol. of Lime - cf	.143
Wt. Moisture	30.24 gm.	Vol. of Pozzolan - cf	.051
Wt. Tare	30.60 gm.	Vol. of Soil - cf	.398
Wt. Dry Soil	149.74 gm.	Vol. of Water - cf	.316
Moisture Content	20.2 %	Vol. of Solids - cf	.592

Sample No.	L1	12	13	14	15	16
Height Dial - .0001	.521	.527	.527	.511	.511	.516
Sample Height - inch	2.021	2.027	2.027	2.011	2.011	2.016
Wt. Wet Sample - gm.	196.22	196.27	196.08	194.24	194.89	195.09
Dry Unit Wt. - pcf	97.7	97.5	97.3	97.3	97.6	97.3
Proving Dial - 0.0001	56	56	60	53	57	53
Unconf. Load - lbs.	430	430	460	410	440	410
Tare No.	V.68	V.31.15	V.76	A.27	V.66	Y.76
Wt. Wet Soil + Tare	122.83	130.01	120.38	130.48	129.97	119.34
Wt. Dry Soil + Tare	112.69	117.87	110.31	118.36	118.83	109.23
Wt. of Moisture	10.14	12.14	10.07	12.12	11.14	10.11
Wt. of Tare	65.25	61.32	64.97	61.35	66.30	61.42
Wt. Dry Soil	47.44	56.55	45.34	57.01	52.53	47.81
Soaked Moist. Cont. %	21.4	21.5	22.2	19.8	21.2	21.2
Soaked Dial Height	.519	.522	.529	.509	.506	.514

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	10Q
Optimum Moisture Content	21.2 %	Lime-Pozzolan Ratio	7:3
Wt. Lime [28 %]	392 gm.	Percent Additive	40
Wt. Pozzolan [12 %]	168 gm.	Date Constructed	7·2·61
Wt. Soil	840 gm.	Date Broken	8·3·61
Wt. Dry Mix	1400 gm.	**Results**	
Wt. Water	296 gm.	Aver. Dry Unit Wt. - pcf	94.2
Moulding Moisture Content		Aver. Unconf. Load - lbs.	540
Container No.	J.190	Aver. Unconf. Press. - psi	172
Wt. Wet Soil + Tare	130.00 gm.	Aver. Soaked Moist. - %	23.6
Wt. Dry Soil + Tare	111.02 gm.	Vol. of Lime - cf	.188
Wt. Moisture	18.98 gm.	Vol. of Pozzolan - cf	.066
Wt. Tare	22.48 gm.	Vol. of Soil - cf	.330
Wt. Dry Soil	88.54 gm.	Vol. of Water - cf	.324
Moisture Content	21.5 %	Vol. of Solids - cf	.584

Sample No.	L1	12	13	14	15	16
Height Dial - .0001	.545	.482	.496	.500	.494	.484
Sample Height - inch	2.045	1.982	1.996	2.000	1.994	1.984
Wt. Wet Sample - gm.	193.70	188.68	188.35	188.52	188.42	187.80
Dry Unit Wt. - pcf	94.2	94.7	94.0	93.8	94.0	94.2
Proving Dial - 0.0001	70	67	71	73	71	70
Unconf. Load - lbs.	540	520	550	570	550	540
			▽			
Tare No.	V.59.16	V.65	V.44	V.29	V.59	V.79
Wt. Wet Soil + Tare	129.23	118.11	107.86	124.68	119.04	112.28
Wt. Dry Soil + Tare	117.38	107.96	98.26	113.53	108.68	102.21
Wt. of Moisture	11.85	10.15	9.60	11.15	10.36	10.07
Wt. of Tare	66.60	64.68	58.41	66.29	64.04	59.72
Wt. Dry Soil	50.78	43.28	39.85	47.24	44.64	42.49
Soaked Moist. Cont. %	23.4	23.5	24.0	23.6	23.2	23.7
Soaked Dial Height	.541	.497	.495	.493	.486	.483

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	10R
Optimum Moisture Content	20.0 %	Lime-Pozzolan Ratio	9:1
Wt. Lime [27 %]	378 gm.	Percent Additive	30
Wt. Pozzolan [3 %]	42 gm.	Date Constructed	1.2.61
Wt. Soil	980 gm.	Date Broken	2.3.61
Wt. Dry Mix	1400 gm.	**Results**	
Wt. Water	280 gm.	Aver. Dry Unit Wt. - pcf	95.3
Moulding Moisture Content		Aver. Unconf. Load - lbs.	370
Container No.	J.147	Aver. Unconf. Press. - psi	118
Wt. Wet Soil + Tare	138.37 gm.	Aver. Soaked Moist. - %	22.4
Wt. Dry Soil + Tare	120.98 gm.	Vol. of Lime - cf	.204
Wt. Moisture	17.39 gm.	Vol. of Pozzolan - cf	.016
Wt. Tare	30.20 gm.	Vol. of Soil - cf	.373
Wt. Dry Soil	90.78 gm.	Vol. of Water - cf	.292
Moisture Content	19.1 %	Vol. of Solids - cf	.593

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.473	.513	.507	.501	.509	.528
Sample Height - inch	1.973	2.013	2.007	2.001	2.009	2.028
Wt. Wet Sample - gm.	186.13	188.91	188.56	188.36	188.80	188.80
Dry Unit Wt. - pcf	95.8	95.2	95.3	95.6	95.4	94.6
Proving Dial - 0.0001	43	47	49	49	52	49
Unconf. Load - lbs.	330	360	370	370	400	370
Tare No.	A.81.64	A.27	V.5	V.78	V.57.10	V.59.16
Wt. Wet Soil + Tare	130.08	113.01	120.48	157.52	129.53	127.69
Wt. Dry Soil + Tare	118.08	103.55	110.37	143.97	119.07	116.58
Wt. of Moisture	12.00	9.46	10.11	13.55	10.46	11.11
Wt. of Tare	66.41	61.35	65.44	82.61	71.51	66.60
Wt. Dry Soil	51.67	42.20	44.93	61.36	47.56	49.98
Soaked Moist. Cont. %	23.2	22.4	22.6	22.2	22.0	22.3
Soaked Dial Height	.478	.515	.507	.496	.508	.522

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	10S
Optimum Moisture Content	18.7 %	Lime-Pozzolan Ratio	20:3
Wt. Lime [20 %]	280 gm.	Percent Additive	23
Wt. Pozzolan [3 %]	42 gm.	Date Constructed	2.2.61
Wt. Soil	1078 gm.	Date Broken	3.3.61
Wt. Dry Mix	1400 gm.	Results	
Wt. Water	262 gm.	Aver. Dry Unit Wt. - pcf	99.7
Moulding Moisture Content		Aver. Unconf. Load - lbs.	350
Container No.	J.156	Aver. Unconf. Press. - psi	111
Wt. Wet Soil + Tare	152.18 gm.	Aver. Soaked Moist. - %	20.4
Wt. Dry Soil + Tare	132.72 gm.	Vol. of Lime - cf	.142
Wt. Moisture	19.46 gm.	Vol. of Pozzolan - cf	.018
Wt. Tare	31.18 gm.	Vol. of Soil - cf	.448
Wt. Dry Soil	101.54 gm.	Vol. of Water - cf	.303
Moisture Content	19.2 %	Vol. of Solids - cf	.608

Sample No:	1	2	3	4	5	6
Height Dial - .0001	.495	.515	.506	.511	.515	.521
Sample Height - inch	1.995	2.015	2.006	2.011	2.015	2.021
Wt. Wet Sample - gm.	197.62	197.64	197.00	197.61	197.52	197.77
Dry Unit Wt. - pcf	100.5	99.5	99.7	99.8	99.6	99.3
Proving Dial - 0.0001	42	48	45	47	47	45
Unconf. Load - lbs.	320	370	340	360	360	340
Tare No.	V.79	V.76	V.78	V.5	V.74	V.27
Wt. Wet Soil + Tare	122.82	121.29	147.09	125.57	139.08	120.76
Wt. Dry Soil + Tare	112.18	110.91	136.30	115.57	126.79	110.64
Wt. of Moisture	10.64	10.38	10.79	10.00	12.29	10.12
Wt. of Tare	59.72	61.50	82.61	65.44	66.54	61.35
Wt. Dry Soil	52.46	50.41	53.69	50.13	60.25	49.29
Soaked Moist. Cont. %	20.4	20.6	20.1	20.0	20.4	20.6
Soaked Dial Height	.498	.515	499	.505	.515	.512

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	10T
Optimum Moisture Content	16.5 %	Lime-Pozzolan Ratio	10:3
Wt. Lime [10 %]	140 gm.	Percent Additive	13
Wt. Pozzolan [3 %]	42 gm.	Date Constructed	2-2-61
Wt. Soil	1218 gm.	Date Broken	3-3-61
Wt. Dry Mix	1400 gm.	**Results**	
Wt. Water	231 gm.	Aver. Dry Unit Wt. - pcf	103.6
Moulding Moisture Content		Aver. Unconf. Load - lbs.	320
Container No.	J.153	Aver. Unconf. Press. - psi	102
Wt. Wet Soil + Tare	127.07 gm.	Aver. Soaked Moist. - %	19.0
Wt. Dry Soil + Tare	113.20 gm.	Vol. of Lime - cf	.074
Wt. Moisture	13.87 gm.	Vol. of Pozzolan - cf	.018
Wt. Tare	29.93 gm.	Vol. of Soil - cf	.527
Wt. Dry Soil	83.27 gm.	Vol. of Water - cf	.277
Moisture Content	16.7 %	Vol. of Solids - cf	.619

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.514	.514	.522	.518	.519	.521
Sample Height - inch	2.014	2.014	2.022	2.018	2.019	2.021
Wt. Wet Sample - gm.	201.70	201.08	201.40	200.93	201.66	201.59
Dry Unit Wt. - pcf	104.0	103.7	103.5	103.2	103.7	103.6
		▽				
Proving Dial - 0.0001	42	42	41	40	43	42
Unconf. Load - lbs.	320	320	310	300	330	320
Tare No.	A.25	V.47	V.71	A.14.14	A.13	V16.59
Wt. Wet Soil + Tare	116.70	119.42	146.90	123.71	134.37	136.92
Wt. Dry Soil + Tare	107.92	109.88	135.53	114.12	123.77	125.80
Wt. of Moisture	8.78	9.54	11.37	9.59	10.60	11.12
Wt. of Tare	60.48	63.90	74.49	62.75	66.22	66.60
Wt. Dry Soil	47.44	45.98	41.04	51.37	57.55	59.20
Soaked Moist. Cont. %	18.5	20.6	27.6	18.7	18.4	18.8
Soaked Dial Height	.509	.507	.509	—	.512	.508

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	10 U
Optimum Moisture Content	15.0 %	Lime-Pozzolan Ratio	5.0
Wt. Lime [5 %]	70 gm.	Percent Additive	5
Wt. Pozzolan [0 %]	0 gm.	Date Constructed	3.2.61
Wt. Soil	1330 gm.	Date Broken	4.3.61
Wt. Dry Mix	1400 gm.	**Results**	
Wt. Water	210 gm.	Aver. Dry Unit Wt. - pcf	107.1
Moulding Moisture Content		Aver. Unconf. Load - lbs.	260
Container No.	J.158	Aver. Unconf. Press. - psi	83
Wt. Wet Soil + Tare	149.80 gm.	Aver. Soaked Moist. - %	17.8
Wt. Dry Soil + Tare	134.00 gm.	Vol. of Lime - cf	.023
Wt. Moisture	15.80 gm.	Vol. of Pozzolan - cf	—
Wt. Tare	30.25 gm.	Vol. of Soil - cf	.607
Wt. Dry Soil	103.75 gm.	Vol. of Water - cf	.261
Moisture Content	15.2 %	Vol. of Solids - cf	.630

Sample No:	1	2	3	4	5	6
Height Dial - .0001	.518	.509	.513	.508	.507	.511
Sample Height - inch	2.018	2.009	2.013	2.008	2.007	2.011
Wt. Wet Sample - gm.	205.91	205.30	204.54	204.63	204.95	205.22
Dry Unit Wt. - pcf	107.0	107.4	106.7	107.0	107.3	107.1
Proving Dial - 0.0001	34	35	32	35	37	34
Unconf. Load - lbs.	260	270	240	270	280	260
Tare No.	V.44	V.52	A.26.2	V31.15	V.68	A.27
Wt. Wet Soil + Tare	130.61	134.80	124.97	116.87	134.38	125.12
Wt. Dry Soil + Tare	119.75	125.18	115.10	108.46	124.00	115.41
Wt. of Moisture	10.86	9.62	9.87	8.41	10.38	9.71
Wt. of Tare	58.41	70.55	59.40	61.32	65.25	61.35
Wt. Dry Soil	61.34	54.63	55.70	47.14	58.75	54.06
Soaked Moist. Cont. %	17.8	17.6	17.7	17.8	17.7	18.0
Soaked Dial Height	.513	.507	.509	.512	.503	.510

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LIME POZZOLAN SOIL STABILIZATION

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Optimum Moisture Content	16.0 %	Series No.	10V
Wt. Lime [10 %]	140 gm.	Lime-Pozzolan Ratio	10.0
Wt. Pozzolan [nil %]	nil gm.	Percent Additive	10
Wt. Soil	1260 gm.	Date Constructed	3.2.61
Wt. Dry Mix	1400 gm.	Date Broken	4.3.61
Wt. Water	225 gm.	**Results**	
Moulding Moisture Content		Aver. Dry Unit Wt. - pcf	104.8
Container No.	J.160	Aver. Unconf. Load - lbs.	270
Wt. Wet Soil + Tare	omitted gm.	Aver. Unconf. Press. - psi	86
Wt. Dry Soil + Tare	gm.	Aver. Soaked Moist. - %	18.6
Wt. Moisture	gm.	Vol. of Lime - cf	.075
Wt. Tare	gm.	Vol. of Pozzolan - cf	—
Wt. Dry Soil	gm.	Vol. of Soil - cf	.550
		Vol. of Water - cf	.269
Moisture Content	use 16.0 %	Vol. of Solids - cf	.625

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.497	.508	.512	.513	.504	.502
Sample Height - inch	1.997	2.008	2.012	2.013	2.004	2.002
Wt. Wet Sample - gm.	201.80	201.90	201.64	201.98	201.28	201.72
Dry Unit Wt. - pcf	105.3	104.8	104.5	104.8	104.6	104.9
Proving Dial - 0.0001	33	37	36	37	35	37
Unconf. Load - lbs.	250	280	280	280	270	280
					▽	
Tare No.	A.16.59	Y.18	A.20	V.66	V.59	V.65
Wt. Wet Soil + Tare	133.41	112.17	133.37	133.75	123.90	122.68
Wt. Dry Soil + Tare	122.90	104.18	122.72	123.22	113.88	113.60
Wt. of Moisture	10.51	7.99	10.65	10.53	10.02	9.08
Wt. of Tare	66.60	60.32	66.37	66.30	64.04	64.68
Wt. Dry Soil	56.30	43.86	56.35	56.92	49.84	48.92
Soaked Moist. Cont. %	18.7	18.3	18.9	18.5	20.2	18.2
Soaked Dial Height	.496	.503	.503	.497	.497	.494

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	10W
Optimum Moisture Content	18.0 %	Lime-Pozzolan Ratio	20:0
Wt. Lime [20 %]	280 gm.	Percent Additive	20
Wt. Pozzolan [nil %]	nil gm.	Date Constructed	3·2·61
Wt. Soil	1120 gm.	Date Broken	4·3·61
Wt. Dry Mix	1400 gm.	**Results**	
Wt. Water	252 gm.	Aver. Dry Unit Wt. - pcf	99.8
Moulding Moisture Content		Aver. Unconf. Load - lbs.	340
Container No.	J.162	Aver. Unconf. Press. - psi	108
Wt. Wet Soil + Tare	154.54 gm.	Aver. Soaked Moist. - %	20.0
Wt. Dry Soil + Tare	135.62 gm.	Vol. of Lime - cf	.142
Wt. Moisture	18.92 gm.	Vol. of Pozzolan - cf	—
Wt. Tare	30.48 gm.	Vol. of Soil - cf	.467
Wt. Dry Soil	105.14 gm.	Vol. of Water - cf	.288
Moisture Content	18.0 %	Vol. of Solids - cf	.609

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.498	.513	.499	.510	.493	.504
Sample Height - inch	1.998	2.013	1.999	2.010	1.993	2.004
Wt. Wet Sample - gm.	194.75	195.72	194.60	195.27	194.93	195.30
Dry Unit Wt. - pcf	99.9	99.7	99.8	99.6	100.1	99.8
Proving Dial - 0.0001	42	46	44	43	46	46
Unconf. Load - lbs.	320	350	340	330	350	350
Tare No.	132	133	134	135	136	137
Wt. Wet Soil + Tare	161.39	155.86	164.23	158.69	168.61	186.83
Wt. Dry Soil + Tare	149.39	144.22	151.31	147.40	155.00	170.80
Wt. of Moisture	12.00	11.64	12.92	11.29	13.61	16.03
Wt. of Tare	89.55	84.93	86.31	90.37	87.52	91.89
Wt. Dry Soil	57.84	59.29	65.00	57.03	68.48	78.91
Soaked Moist. Cont. %	20.8	19.6	19.9	19.7	19.9	20.3
Soaked Dial Height	.490	.496	—	.503	.485	.490

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LIME POZZOLAN SOIL STABILIZATION

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		SERIES NO.	10X
OPTIMUM MOISTURE CONTENT	13.5 %	LIME-POZZOLAN RATIO	—
WT. LIME [nil %]	nil GM.	PERCENT ADDITIVE	nil
WT. POZZOLAN [nil %]	nil GM.	DATE CONSTRUCTED	2.2.61
WT. SOIL	1500 GM.	DATE BROKEN	3.3.61
WT. DRY MIX	1500 GM.	RESULTS	
WT. WATER	202 GM.	AVER. DRY UNIT WT. - PCF	117.1
MOULDING MOISTURE CONTENT		AVER. UNCONF. LOAD - LBS. *	390
CONTAINER NO.	J.150	AVER. UNCONF. PRESS. - PSI *	124
WT. WET SOIL + TARE	148.54 GM.	AVER. SOAKED MOIST. - %	14.0
WT. DRY SOIL + TARE	134.28 GM.	VOL. OF LIME - CF	—
WT. MOISTURE	14.26 GM.	VOL. OF POZZOLAN - CF	—
WT. TARE	31.72 GM.	VOL. OF SOIL - CF	.685
WT. DRY SOIL	102.56 GM.	VOL. OF WATER - CF	.261
MOISTURE CONTENT	13.9 %	VOL. OF SOLIDS - CF	.685

SAMPLE NO.	1	2	3	4	5	6
HEIGHT DIAL - .0001	.468	.510	.507	.498	.510	.516
SAMPLE HEIGHT - INCH	1.968	2.010	2.007	1.998	2.010	2.016
WT. WET SAMPLE - GM.	218.08	220.89	221.56	221.05	221.53	221.41
DRY UNIT WT. - PCF	117.7	116.7	117.3	117.3	117.0	116.7
PROVING DIAL - 0.0001	53	51	54	46	54	51
UNCONF. LOAD - LBS.	410	390	410	350	410	390
TARE NO.	V.22	V.50	V.49	V.29	H.13	H.14
WT. WET SOIL + TARE	120.60	142.16	122.98	124.88	127.97	116.68
WT. DRY SOIL + TARE	114.88	134.80	115.52	117.57	117.30	107.34
WT. OF MOISTURE	5.72	7.36	7.46	7.31	10.67	9.34
WT. OF TARE	73.95	81.41	62.90	66.29	40.20	40.58
WT. DRY SOIL	41.93	53.49	52.62	51.28	77.10	66.76
SOAKED MOIST. CONT. %	13.7	13.8	14.2	14.3	13.8	14.0
SOAKED DIAL HEIGHT	.463	.503	.510	.495	.504	.506

* Samples not soaked.

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	55A
Optimum Moisture Content	18.0 %	Lime-Pozzolan Ratio	5:5
Wt. Lime [20 %]	280 gm.	Percent Additive	40
Wt. Pozzolan [20 %]	280 gm.	Date Constructed	4.2.61
Wt. Soil	840 gm.	Date Broken	5.3.61
Wt. Dry Mix	1400 gm.	**Results**	
Wt. Water	252 gm.	Aver. Dry Unit Wt. - pcf	102.2
Moulding Moisture Content		Aver. Unconf. Load - lbs.	1570
Container No.	J.180	Aver. Unconf. Press. - psi	500
Wt. Wet Soil + Tare	99.80 gm.	Aver. Soaked Moist. - %	20.7
Wt. Dry Soil + Tare	89.71 gm.	Vol. of Lime - cf	.145
Wt. Moisture	10.09 gm.	Vol. of Pozzolan - cf	.118
Wt. Tare	31.32 gm.	Vol. of Soil - cf	.359
Wt. Dry Soil	58.39 gm.	Vol. of Water - cf	.284
Moisture Content	17.3 %	Vol. of Solids - cf	.622

Sample No:	1	2	3	4	5	6
Height Dial - .0001	.450	.490	.499	.507	.511	.493
Sample Height - inch	1.950	1.990	1.999	2.007	2.011	1.993
Wt. Wet Sample - gm.	193.70	198.58	198.52	198.75	198.65	198.20
Dry Unit Wt. - pcf	102.2	102.8	102.3	102.0	101.7	102.4
Proving Dial - 0.0001	183	193	209	213	174	200
Unconf. Load - lbs.	1450	1540	1670	1780	1380	1580
Tare No.	A.13	A.16.59	V.18	V.5	V.49	V.52
Wt. Wet Soil + Tare	97.50	100.60	107.20	101.90	106.38	102.65
Wt. Dry Soil + Tare	92.15	94.82	99.12	95.65	98.85	97.06
Wt. of Moisture	5.35	5.78	8.08	6.25	7.53	5.59
Wt. of Tare	66.22	66.60	60.32	65.44	62.90	70.55
Wt. Dry Soil	25.93	28.22	38.80	30.21	35.95	26.51
Soaked Moist. Cont. %	20.6	20.5	20.8	20.6	20.9	21.0
Soaked Dial Height	.452	.493	.504	.507	515	.497

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LIME POZZOLAN SOIL STABILIZATION

		SERIES NO.	558
OPTIMUM MOISTURE CONTENT	18.0 %	LIME-POZZOLAN RATIO	3:7
WT. LIME [12 %]	168 GM.	PERCENT ADDITIVE	40
WT. POZZOLAN [28 %]	392 GM.	DATE CONSTRUCTED	6·2·61
WT. SOIL	840 GM.	DATE BROKEN	7·3·61
WT. DRY MIX	1400 GM.	RESULTS	
WT. WATER	252 GM.	AVER. DRY UNIT WT. - PCF	103.5
MOULDING MOISTURE CONTENT		AVER. UNCONF. LOAD - LBS.	1830
CONTAINER NO.	J.181	AVER. UNCONF. PRESS. - PSI	582
WT. WET SOIL + TARE	130.90 GM.	AVER. SOAKED MOIST. - %	21.4
WT. DRY SOIL + TARE	117.33 GM.	VOL. OF LIME - CF	.088
WT. MOISTURE	13.57 GM.	VOL. OF POZZOLAN - CF	.170
WT. TARE	40.60 GM.	VOL. OF SOIL - CF	.363
WT. DRY SOIL	76.73 GM.	VOL. OF WATER - CF	.293
MOISTURE CONTENT	17.7 %	VOL. OF SOLIDS - CF	.621

SAMPLE NO.	11	12	13	14	15	16
HEIGHT DIAL - .0001	.504	.500	.513	.520	.509	.509
SAMPLE HEIGHT - INCH	2.004	2.000	2.013	2.020	2.009	2.009
WT. WET SAMPLE - GM.	201.60	201.68	202.60	202.51	202.48	202.30
DRY UNIT WT. - PCF	103.3	103.7	103.4	103.1	103.7	103.7
PROVING DIAL - 0.0001	227	227	237	* 185	226	229
UNCONF. LOAD - LBS.	1810	1810	1890	1470	1800	1830
TARE NO.	V.66	V.71	V.26	V.47	A.14-14	A.25
WT. WET SOIL + TARE	103.82	121.87	103.70	98.56	102.80	92.52
WT. DRY SOIL + TARE	97.09	113.70	97.30	92.50	95.70	86.95
WT. OF MOISTURE	6.73	8.17	6.40	6.06	7.10	5.57
WT. OF TARE	66.30	74.49	68.50	63.90	62.80	60.48
WT. DRY SOIL	30.79	39.21	28.80	28.60	32.90	26.47
SOAKED MOIST. CONT. %	21.9	20.8	22.2	21.2	21.6	21.0
SOAKED DIAL HEIGHT	.507	.510	.520	.527	.514	.514

* Eccentric Loading

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LIME POZZOLAN SOIL STABILIZATION

		SERIES NO.	55 C
OPTIMUM MOISTURE CONTENT	16.6 %	LIME-POZZOLAN RATIO	5:5
WT. LIME [15 %]	210 GM.	PERCENT ADDITIVE	30
WT. POZZOLAN [15 %]	210 GM.	DATE CONSTRUCTED	6.2.61
WT. SOIL	980 GM.	DATE BROKEN	7.3.61
WT. DRY MIX	1400 GM.	RESULTS	
WT. WATER	232 GM.	AVER. DRY UNIT WT. - PCF	104.9
MOULDING MOISTURE CONTENT		AVER. UNCONF. LOAD - LBS.	1160
CONTAINER NO.	J.186	AVER. UNCONF. PRESS. - PSI	369
WT. WET SOIL + TARE	109.71 GM.	AVER. SOAKED MOIST. - %	19.2
WT. DRY SOIL + TARE	98.01 GM.	VOL. OF LIME - CF	.112
WT. MOISTURE	11.70 GM.	VOL. OF POZZOLAN - CF	.092
WT. TARE	31.32 GM.	VOL. OF SOIL - CF	.429
WT. DRY SOIL	66.69 GM.	VOL. OF WATER - CF	.295
MOISTURE CONTENT	17.5 %	VOL. OF SOLIDS - CF	.633

SAMPLE NO.	L1	12	13	14	15	16
HEIGHT DIAL - .0001	.550	.497	.490	.495	.485	.514
SAMPLE HEIGHT - INCH	2.050	1.997	1.990	1.995	1.985	2.014
WT. WET SAMPLE - GM.	209.85	203.40	202.95	203.21	202.40	203.88
DRY UNIT WT. - PCF	105.2	105.0	105.1	104.9	105.1	104.1
PROVING DIAL - 0.0001	157	143	151	150	137	147
UNCONF. LOAD - LBS.	1240	1130	1190	1180	1080	1160
			▽	▽		
TARE NO.	V.79	V.28	V.29	V.78	A.17	V.44
WT. WET SOIL + TARE	115.04	131.56	122.65	151.06	120.60	117.10
WT. DRY SOIL + TARE	106.34	123.85	113.31	139.67	112.69	107.72
WT. OF MOISTURE	8.70	7.71	9.34	11.39	7.91	9.38
WT. OF TARE	59.72	82.58	66.29	82.61	70.19	58.41
WT. DRY SOIL	46.62	41.27	47.02	57.06	42.50	49.31
SOAKED MOIST. CONT. %	19.5	18.7	19.8	19.8	18.6	19.0
SOAKED DIAL HEIGHT	.560	.503	.493	.498	.490	.514

▽ SAMPLE SOAKED DURING CURING PERIOD

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LIME POZZOLAN SOIL STABILIZATION

		SERIES NO.	55D
OPTIMUM MOISTURE CONTENT	15.0 %	LIME-POZZOLAN RATIO	5:5
WT. LIME [10 %]	130 GM.	PERCENT ADDITIVE	20
WT. POZZOLAN [10 %]	130 GM.	DATE CONSTRUCTED	24.1.61
WT. SOIL	1040 GM.	DATE BROKEN	22.2.61
WT. DRY MIX	1300 GM.	RESULTS	
WT. WATER	195 GM.	AVER. DRY UNIT WT. - PCF	106.8
MOULDING MOISTURE CONTENT		AVER. UNCONF. LOAD - LBS.	760
CONTAINER NO.	J.108	AVER. UNCONF. PRESS. - PSI	242
WT. WET SOIL + TARE	122.17 GM.	AVER. SOAKED MOIST. - %	17.5
WT. DRY SOIL + TARE	110.30 GM.	VOL. OF LIME - CF	.076
WT. MOISTURE	11.87 GM.	VOL. OF POZZOLAN - CF	.063
WT. TARE	30.91 GM.	VOL. OF SOIL - CF	.500
WT. DRY SOIL	79.39 GM.	VOL. OF WATER - CF	.256
MOISTURE CONTENT	15.0 %	VOL. OF SOLIDS - CF	.639

SAMPLE NO.	1	2	3	4	5	6
HEIGHT DIAL - .0001	.485	.505	.509	.506	.523	.500
SAMPLE HEIGHT - INCH	1.985	2.005	2.009	2.006	2.023	2.000
WT. WET SAMPLE - GM.	201.63	203.68	204.27	203.39	204.12	203.80
DRY UNIT WT. - PCF	106.8	106.8	107.0	106.8	106.1	107.1
PROVING DIAL - 0.0001	85	88	106	103	96	106
UNCONF. LOAD - LBS.	660	690	830	810	750	830
TARE NO.	V.63	A.27	V33	Y.47	V.18	V85
WT. WET SOIL + TARE	115.86	117.10	125.58	101.78	108.84	122.28
WT. DRY SOIL + TARE	108.37	108.68	118.23	96.13	101.55	116.07
WT. OF MOISTURE	7.49	8.42	7.35	5.65	7.29	6.21
WT. OF TARE	66.72	61.35	75.18	63.90	60.32	80.28
WT. DRY SOIL	42.65	47.33	43.05	32.23	41.23	35.79
SOAKED MOIST. CONT. %	17.5	17.8	17.2	17.5	17.7	17.4
SOAKED DIAL HEIGHT	.483	.504	.507	.510	.527	.505

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	55E
Optimum Moisture Content	13.6 %	Lime-Pozzolan Ratio	5:5
Wt. Lime [5 %]	70 gm.	Percent Additive	10
Wt. Pozzolan [5 %]	70 gm.	Date Constructed	25·1·61
Wt. Soil	1260 gm.	Date Broken	23·2·61
Wt. Dry Mix	1400 gm.	**Results**	
Wt. Water	190 gm.	Aver. Dry Unit Wt. - pcf	110·1
Moulding Moisture Content		Aver. Unconf. Load - lbs.	600
Container No.	J·113	Aver. Unconf. Press. - psi	191
Wt. Wet Soil + Tare	148.72 gm.	Aver. Soaked Moist. - %	16.5
Wt. Dry Soil + Tare	133.60 gm.	Vol. of Lime - cf	.039
Wt. Moisture	15.12 gm.	Vol. of Pozzolan - cf	.032
Wt. Tare	30.49 gm.	Vol. of Soil - cf	.578
Wt. Dry Soil	103.11 gm.	Vol. of Water - cf	.258
Moisture Content	14.6 %	Vol. of Solids - cf	.649

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.477	510	501	487	.549	.522
Sample Height - inch	1.977	2.010	2.001	1.987	2.049	2.022
Wt. Wet Sample - gm.	207.66	209.90	210.02	209.72	209.12	210.25
Dry Unit Wt. - pcf	110.8	110.2	110.8	111.3	107.7	109.8
Proving Dial - 0.0001	82	84	91	88	37	77
Unconf. Load - lbs.	640	650	710	690	280	600
Tare No.	V.47	V.82	V.55	V44	A.17	V.31.15
Wt. Wet Soil + Tare	111.54	107.48	110.74	103.49	140.10	109.86
Wt. Dry Soil + Tare	104.88	100.87	104.32	97.26	129.53	102.95
Wt. of Moisture	6.66	6.61	6.42	6.23	10.57	6.91
Wt. of Tare	63.90	60.05	64.02	58.41	70.19	61.32
Wt. Dry Soil	40.98	40.82	40.30	38.85	58.34	41.63
Soaked Moist. Cont. %	16.2	16.2	15.9	16.0	18.1	16.6
Soaked Dial Height	.485	.517	.506	.497	.563	.528

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LIME POZZOLAN SOIL STABILIZATION

		SERIES NO.	55F
OPTIMUM MOISTURE CONTENT	13.0 %	LIME-POZZOLAN RATIO	5:5
WT. LIME [3 %]	42 GM.	PERCENT ADDITIVE	6
WT. POZZOLAN [3 %]	42 GM.	DATE CONSTRUCTED	25·1·61
WT. SOIL	1316 GM.	DATE BROKEN	23·2·61
WT. DRY MIX	1400 GM.	RESULTS	
WT. WATER	182 GM.	AVER. DRY UNIT WT. - PCF	113.3
MOULDING MOISTURE CONTENT		AVER. UNCONF. LOAD - LBS.	680
CONTAINER NO.	J·116	AVER. UNCONF. PRESS. - PSI	216
WT. WET SOIL + TARE	137.97 GM.	AVER. SOAKED MOIST. - %	15.2
WT. DRY SOIL + TARE	124.71 GM.	VOL. OF LIME - CF	.024
WT. MOISTURE	13.26 GM.	VOL. OF POZZOLAN - CF	.020
WT. TARE	31.07 GM.	VOL. OF SOIL - CF	.622
WT. DRY SOIL	93.64 GM.	VOL. OF WATER - CF	.256
MOISTURE CONTENT	14.1 %	VOL. OF SOLIDS - CF	.666

SAMPLE NO.	1	2	3	4	5	6
HEIGHT DIAL - .0001	.481	.490	.468	.491	.476	.477
SAMPLE HEIGHT - INCH	1.981	1.990	1.968	1.991	1.976	1.977
WT. WET SAMPLE - GM.	212.70	211.99	212.00	212.87	212.72	212.65
DRY UNIT WT. - PCF	113.8	112.8	114.2	113.2	112.0	114.0
PROVING DIAL - 0.0001	83	70	90	96	92	89
UNCONF. LOAD - LBS.	650	540	700	750	720	690
TARE NO.	V64.81	V41	A.3	A.14	A.24	A.20
WT. WET SOIL + TARE	130.10	104.32	111.42	116.08	89.00	112.16
WT. DRY SOIL + TARE	121.54	97.81	104.61	109.15	85.21	106.10
WT. OF MOISTURE	8.56	6.51	6.81	6.93	3.79	6.06
WT. OF TARE	66.41	56.10	58.85	62.75	59.97	66.37
WT. DRY SOIL	55.13	41.71	45.76	46.40	25.24	39.73
SOAKED MOIST. CONT. %	15.5	15.6	14.9	14.9	15.0	15.1
SOAKED DIAL HEIGHT	.487	.498	.476	.493	.481	.478

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LIME POZZOLAN SOIL STABILIZATION

		SERIES NO.	55 G
OPTIMUM MOISTURE CONTENT	16.6 %	LIME-POZZOLAN RATIO	3:7
WT. LIME [9 %]	126 GM.	PERCENT ADDITIVE	30
WT. POZZOLAN [21 %]	294 GM.	DATE CONSTRUCTED	26 · 1 · 61
WT. SOIL	980 GM.	DATE BROKEN	24 · 2 · 61
WT. DRY MIX	1400 GM.	RESULTS	
WT. WATER	232 GM.	AVER. DRY UNIT WT. - PCF	105.3
MOULDING MOISTURE CONTENT		AVER. UNCONF. LOAD - LBS.	1260
CONTAINER NO.	J·119	AVER. UNCONF. PRESS. - PSI	401
WT. WET SOIL + TARE	139.93 GM.	AVER. SOAKED MOIST. - %	19.6
WT. DRY SOIL + TARE	125.53 GM.	VOL. OF LIME - CF	.068
WT. MOISTURE	14.40 GM.	VOL. OF POZZOLAN - CF	.129
WT. TARE	30.22 GM.	VOL. OF SOIL - CF	.431
WT. DRY SOIL	95.31 GM.	VOL. OF WATER - CF	.255
MOISTURE CONTENT	15.1 %	VOL. OF SOLIDS - CF	.628

SAMPLE NO.	1	2	3	4	5	6
HEIGHT DIAL - .0001	.464	.490	.508	.498	.511	.509
SAMPLE HEIGHT - INCH	1.964	1.990	2.008	1.998	2.011	2.009
WT. WET SAMPLE - GM.	195.90	200.43	200.70	200.68	201.80	200.81
DRY UNIT WT. - PCF	104.9	106.0	105.1	105.5	105.4	105.1
PROVING DIAL - 0.0001	145	173	158	161	161	159
UNCONF. LOAD - LBS.	1140	1360	1250	1270	1270	1250
TARE NO.	V·26	V·28	V·31·15	V·5	A·24	V·82
WT. WET SOIL + TARE	113.39	130.12	97.36	106.90	110.08	105.63
WT. DRY SOIL + TARE	106.01	122.41	91.38	100.11	101.95	98.10
WT. OF MOISTURE	7.38	7.61	5.98	6.79	8.13	7.53
WT. OF TARE	68.50	82.58	61.32	65.44	59.97	60.05
WT. DRY SOIL	37.51	39.83	30.06	34.67	41.98	38.05
SOAKED MOIST. CONT. %	19.7	19.1	20.0	19.5	19.4	19.8
SOAKED DIAL HEIGHT	460	496	.515	.504	.512	.510

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	55H
Optimum Moisture Content	15.0 %	Lime-Pozzolan Ratio	3:7
Wt. Lime [6 %]	84 gm.	Percent Additive	20
Wt. Pozzolan [14 %]	196 gm.	Date Constructed	26 · 1 · 61
Wt. Soil	1120 gm.	Date Broken	24 · 2 · 61
Wt. Dry Mix	1400 gm.	Results	
Wt. Water	210 gm.	Aver. Dry Unit Wt. - pcf	108.1
Moulding Moisture Content		Aver. Unconf. Load - lbs.	870
Container No.	J.122	Aver. Unconf. Press. - psi	277
Wt. Wet Soil + Tare	118.33 gm.	Aver. Soaked Moist. - %	17.1
Wt. Dry Soil + Tare	105.87 gm.	Vol. of Lime - cf	.046
Wt. Moisture	12.46 gm.	Vol. of Pozzolan - cf	.088
Wt. Tare	22.46 gm.	Vol. of Soil - cf	506
Wt. Dry Soil	83.41 gm.	Vol. of Water - cf	.258
Moisture Content	14.9 %	Vol. of Solids - cf	.640

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.505	.488	.506	.528	.518	.526
Sample Height - inch	2.005	1.988	2.006	2.028	2.018	2.026
Wt. Wet Sample - gm.	205.94	205.41	206.52	207.41	207.10	207.48
Dry Unit Wt. - pcf	108.1	108.9	108.5	107.6	107.9	107.8
Proving Dial - 0.0001	98	124	108	110	117	109
Unconf. Load - lbs.	770	970	850	860	920	850
Tare No.	V.63	A.3	A.27	V.41	A.25	V.78
Wt. Wet Soil + Tare	109.60	109.58	114.00	108.28	112.52	137.19
Wt. Dry Soil + Tare	103.22	102.20	106.28	100.92	104.80	128.98
Wt. of Moisture	6.38	7.38	7.72	7.36	7.72	8.21
Wt. of Tare	66.72	58.85	57.82	56.10	60.48	82.61
Wt. Dry Soil	36.50	43.35	48.46	44.82	44.32	46.37
Soaked Moist. Cont. %	18.0	17.1	15.9	16.4	17.4	17.7
Soaked Dial Height	.508	.497	.511	.533	.525	.525

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LIME POZZOLAN SOIL STABILIZATION

		SERIES NO.	55J
OPTIMUM MOISTURE CONTENT	13.5 %	LIME-POZZOLAN RATIO	3:7
WT. LIME [3 %]	42 GM.	PERCENT ADDITIVE	10
WT. POZZOLAN [7 %]	98 GM.	DATE CONSTRUCTED	27·1·61
WT. SOIL	1260 GM.	DATE BROKEN	25·2·61
WT. DRY MIX	1400 GM.	RESULTS	
WT. WATER	189 GM.	AVER. DRY UNIT WT. - PCF	111.4
MOULDING MOISTURE CONTENT		AVER. UNCONF. LOAD - LBS.	710
CONTAINER NO.	J.125	AVER. UNCONF. PRESS. - PSI	226
WT. WET SOIL + TARE	138.64 GM.	AVER. SOAKED MOIST. - %	16.1
WT. DRY SOIL + TARE	125.31 GM.	VOL. OF LIME - CF	.023
WT. MOISTURE	13.33 GM.	VOL. OF POZZOLAN - CF	.046
WT. TARE	30.49 GM.	VOL. OF SOIL - CF	.586
WT. DRY SOIL	94.82 GM.	VOL. OF WATER - CF	.252
MOISTURE CONTENT	14.1 %	VOL. OF SOLIDS - CF	.655

SAMPLE NO.	1	2	3	4	5	6
HEIGHT DIAL - .0001	.467	.508	.509	.504	.524	.565
SAMPLE HEIGHT - INCH	1.967	2.008	2.009	2.004	2.024	2.065
WT. WET SAMPLE - GM.	208.21	212.05	212.22	211.77	212.37	211.48
DRY UNIT WT. - PCF	112.3	112.1	112.2	111.6	111.5	108.5
PROVING DIAL - 0.0001	99	102	91	95	86	71
UNCONF. LOAD - LBS.	770	800	710	740	670	550
	▽				▽	
TARE NO.	V.57.10	A.16.59	A.26.2	V.52	V.44	V.70
WT. WET SOIL + TARE	136.38	133.00	123.35	135.50	129.02	112.11
WT. DRY SOIL + TARE	127.03	124.20	114.90	126.72	118.92	104.58
WT. OF MOISTURE	9.35	8.80	8.45	8.78	10.10	7.53
WT. OF TARE	71.51	66.60	59.40	70.55	58.41	59.97
WT. DRY SOIL	55.52	57.60	55.50	56.17	60.51	44.61
SOAKED MOIST. CONT. %	16.8	15.3	15.2	15.6	16.7	16.9
SOAKED DIAL HEIGHT	.470	.506	.511	.508	.529	.572

▽ SAMPLE SOAKED DURING CURING PERIOD.

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LIME POZZOLAN SOIL STABILIZATION

Optimum Moisture Content	18.0 %	Series No.	55 K
Wt. Lime [4 %]	56 gm.	Lime-Pozzolan Ratio	1:9
Wt. Pozzolan [36 %]	506 gm.	Percent Additive	40
Wt. Soil	838 gm.	Date Constructed	27·1·61
Wt. Dry Mix	1400 gm.	Date Broken	25·2·61
Wt. Water	252 gm.	**Results**	
Moulding Moisture Content		Aver. Dry Unit Wt. - pcf	103.0
		Aver. Unconf. Load - lbs.	1720
Container No.	J·128	Aver. Unconf. Press. - psi	547
Wt. Wet Soil + Tare	148.99 gm.	Aver. Soaked Moist. - %	21.1
Wt. Dry Soil + Tare	131.15 gm.	Vol. of Lime - cf	.029
Wt. Moisture	17.84 gm.	Vol. of Pozzolan - cf	.217
Wt. Tare	30.93 gm.	Vol. of Soil - cf	.362
Wt. Dry Soil	100.22 gm.	Vol. of Water - cf	.293
Moisture Content	17.8 %	Vol. of Solids - cf	.608

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.484	.523	510	.513	514	.524
Sample Height - inch	1.984	2.023	2.010	2.013	2.014	2.024
Wt. Wet Sample - gm.	199.20	202.39	201.81	201.31	201.99	201.68
Dry Unit Wt. - pcf	103.2	102.8	102.9	102.7	104.3	102.2
Proving Dial - 0.0001	209	220	222	226	217	201
Unconf. Load - lbs.	1670	1750	1770	1800	1730	1600
Tare No.	V.76·1	A·14·14	V.41	V.64·81	V.68	A·24
Wt. Wet Soil + Tare	108.82	108.10	117.91	111.50	123.15	107.61
Wt. Dry Soil + Tare	101.35	100.00	107.32	103.59	112.81	99.41
Wt. of Moisture	7.47	8.10	10.59	7.91	10.34	8.20
Wt. of Tare	64.97	62.75	56.10	66.41	65.25	59.97
Wt. Dry Soil	36.38	37.25	51.22	37.18	47.56	39.44
Soaked Moist. Cont. %	20.5	21.7	20.7	21.2	21.7	20.8
Soaked Dial Height	.499	.530	.520	.521	.526	.535

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LIME POZZOLAN SOIL STABILIZATION

Optimum Moisture Content	16.8 %	Series No.	55·L
Wt. Lime [3 %]	42 gm.	Lime-Pozzolan Ratio	1:9
Wt. Pozzolan [27 %]	378 gm.	Percent Additive	30
Wt. Soil	980 gm.	Date Constructed	30·1·61
Wt. Dry Mix	1400 gm.	Date Broken	28·2·61
Wt. Water	235 gm.	**Results**	
Moulding Moisture Content		Aver. Dry Unit Wt. - pcf	106·1
Container No.	J·131	Aver. Unconf. Load - lbs.	1320
Wt. Wet Soil + Tare	148·00 gm.	Aver. Unconf. Press. - psi	420
Wt. Dry Soil + Tare	131·29 gm.	Aver. Soaked Moist. - %	19·4
Wt. Moisture	16·71 gm.	Vol. of Lime - cf	023
Wt. Tare	30·22 gm.	Vol. of Pozzolan - cf	·167
Wt. Dry Soil	101·07 gm.	Vol. of Soil - cf	·435
Moisture Content	16·5 %	Vol. of Water - cf	280
		Vol. of Solids - cf	·625

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.494	490	.489	502	.494	506
Sample Height - inch	1.994	1.990	1.989	2.002	1.994	2.006
Wt. Wet Sample - gm.	204·20	204·03	203·88	204·12	203·60	203·50
Dry Unit Wt. - pcf	106·4	106·4	106·4	105·9	106·0	105·5
Proving Dial - 0.0001	172	164	174	176	168	146
Unconf. Load - lbs.	1370	1300	1380	1400	1330	1160
Tare No.	A·17	V·70	V·26	V·85	A·20	V·79
Wt. Wet Soil + Tare	117·10	117·40	140·30	142·48	125·33	110·70
Wt. Dry Soil + Tare	109·52	108·10	128·16	132·30	115·99	102·61
Wt. of Moisture	7·58	9·30	12·14	10·18	9·34	8·09
Wt. of Tare	70·19	59·97	68·50	80·28	66·37	59·72
Wt. Dry Soil	39·33	48·13	59·66	52·02	49·62	42·89
Soaked Moist. Cont. %	19·3	19·3	20·4	19·5	18·8	18·9
Soaked Dial Height	·501	·494	497	·511	·504	·513

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	55 M
Optimum Moisture Content	13.6 %	Lime-Pozzolan Ratio	7:3
Wt. Lime [7 %]	98 gm.	Percent Additive	10
Wt. Pozzolan [3 %]	42 gm.	Date Constructed	30.1.61
Wt. Soil	1260 gm.	Date Broken	28.2.61
Wt. Dry Mix	1400 gm.	**Results**	
Wt. Water	190 gm.	Aver. Dry Unit Wt. - pcf	110.3
Moulding Moisture Content		Aver. Unconf. Load - lbs.	590
Container No.	J.135	Aver. Unconf. Press. - psi	188
Wt. Wet Soil + Tare	139.90 gm.	Aver. Soaked Moist. - %	15.8
Wt. Dry Soil + Tare	127.47 gm.	Vol. of Lime - cf	.055
Wt. Moisture	12.43 gm.	Vol. of Pozzolan - cf	.019
Wt. Tare	30.63 gm.	Vol. of Soil - cf	.580
Wt. Dry Soil	96.84 gm.	Vol. of Water - cf	.226
Moisture Content	12.8 %	Vol. of Solids - cf	.654

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.503	.523	.506	.511	.526	.521
Sample Height - inch	2.003	2.023	2.006	2.011	2.026	2.021
Wt. Wet Sample - gm.	206.70	207.55	206.84	207.18	207.70	207.22
Dry Unit Wt. - pcf	110.5	110.1	110.7	110.5	109.8	110.1
Proving Dial - 0.0001	76	79	77	77	75	75
Unconf. Load - lbs.	590	610	600	600	580	580
Tare No.	V.65	V.82	A.26.2	V.5	V.57.10	V.52
Wt. Wet Soil + Tare	132.89	119.83	122.54	130.43	132.63	119.51
Wt. Dry Soil + Tare	123.46	111.57	113.82	121.45	124.29	112.65
Wt. of Moisture	9.43	8.26	8.72	8.98	8.34	6.86
Wt. of Tare	64.68	60.05	59.40	65.44	71.51	70.55
Wt. Dry Soil	58.78	51.52	54.42	56.01	52.78	42.10
Soaked Moist. Cont. %	14.8	16.0	16.0	16.0	15.8	16.3
Soaked Dial Height	.500	.520	.505	.508	.522	.523

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LIME POZZOLAN SOIL STABILIZATION

Optimum Moisture Content	15.1 %	Series No.	55N
Wt. Lime [14 %]	196 gm.	Lime-Pozzolan Ratio	7:3
Wt. Pozzolan [6 %]	84 gm.	Percent Additive	20
Wt. Soil	1120 gm.	Date Constructed	6·2·61
Wt. Dry Mix	1400 gm.	Date Broken	7·3·61
Wt. Water	212 gm.	**Results**	
Moulding Moisture Content		Aver. Dry Unit Wt. - pcf	108.0
Container No.	J·187	Aver. Unconf. Load - lbs.	780
Wt. Wet Soil + Tare	112.30 gm.	Aver. Unconf. Press. - psi	248
Wt. Dry Soil + Tare	101.20 gm.	Aver. Soaked Moist. - %	17.4
Wt. Moisture	11.10 gm.	Vol. of Lime - cf	.107
Wt. Tare	29.88 gm.	Vol. of Pozzolan - cf	.038
Wt. Dry Soil	71.32 gm.	Vol. of Soil - cf	.505
Moisture Content	15.6 %	Vol. of Water - cf	.269
		Vol. of Solids - cf	650

Sample No.	L1	12	13	14	15	16
Height Dial - .0001	.472	.497	.500	.495	.501	520
Sample Height - inch	1.972	1.997	2.000	1.995	2.001	2.020
Wt. Wet Sample - gm.	203.08	206.16	206.36	205.80	205.96	207.26
Dry Unit Wt. - pcf	107.8	108.2	108.2	108.0	108.0	107.5
Proving Dial - 0.0001	91	103	111	97	105	88
Unconf. Load - lbs.	710	810	870	760	820	690
Tare No.	Y·57·10	Y·63	A·24	A·27	Y·68	Y·31·15
Wt. Wet Soil + Tare	137.89	120.52	127.54	116.79	116.20	140.57
Wt. Dry Soil + Tare	128.01	112.57	117.62	108.55	108.65	128.68
Wt. of Moisture	9.88	7.95	9.92	8.24	7.55	11.89
Wt. of Tare	71.51	66.72	59.97	61.35	65.25	61.32
Wt. Dry Soil	56.50	45.85	57.65	47.20	43.40	67.36
Soaked Moist. Cont. %	17.5	17.4	17.2	17.4	17.4	17.6
Soaked Dial Height	.469	.493	499	.495	.501	.520

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	55P
Optimum Moisture Content	16.7 %	Lime-Pozzolan Ratio	7:3
Wt. Lime [21 %]	294 gm.	Percent Additive	30
Wt. Pozzolan [9 %]	126 gm.	Date Constructed	7.2.61
Wt. Soil	980 gm.	Date Broken	8.3.61
Wt. Dry Mix	1400 gm.	**Results**	
Wt. Water	234 gm.	Aver. Dry Unit Wt. - pcf	103.9
Moulding Moisture Content		Aver. Unconf. Load - lbs.	940
Container No.	J.188	Aver. Unconf. Press. - psi	299
Wt. Wet Soil + Tare	145.22 gm.	Aver. Soaked Moist. - %	18.2
Wt. Dry Soil + Tare	128.49 gm.	Vol. of Lime - cf	.155
Wt. Moisture	16.73 gm.	Vol. of Pozzolan - cf	.055
Wt. Tare	31.33 gm.	Vol. of Soil - cf	.425
Wt. Dry Soil	97.16 gm.	Vol. of Water - cf	.287
Moisture Content	17.2 %	Vol. of Solids - cf	.635

Sample No.	L1	12	13	14	15	16
Height Dial - .0001	.497	.490	.502	.498	.504	.496
Sample Height - inch	1.997	1.990	2.002	1.998	2.004	1.996
Wt. Wet Sample - gm.	201.70	200.73	201.58	201.02	201.83	201.55
Dry Unit Wt. - pcf	104.1	104.0	103.7	103.8	103.7	104.2
Proving Dial - 0.0001	125	111	129	116	126	116
Unconf. Load - lbs.	980	870	1010	910	990	910
Tare No.	V.33	V.52	V.57.10	A.26.2	A.24	A.3
Wt. Wet Soil + Tare	131.03	123.65	121.50	113.28	108.05	118.53
Wt. Dry Soil + Tare	122.37	115.45	113.80	105.06	100.71	109.31
Wt. of Moisture	8.66	8.20	7.70	8.22	7.34	9.22
Wt. of Tare	75.18	70.55	71.51	59.40	59.97	58.85
Wt. Dry Soil	47.19	44.90	42.29	45.66	40.74	50.46
Soaked Moist. Cont. %	18.3	18.3	18.2	18.0	18.0	18.3
Soaked Dial Height	.497	.488	.500	.497	.503	.495

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	55Q
Optimum Moisture Content	18.0 %	Lime-Pozzolan Ratio	7:3
Wt. Lime [28 %]	392 gm.	Percent Additive	40
Wt. Pozzolan [12 %]	168 gm.	Date Constructed	7.2.61
Wt. Soil	840 gm.	Date Broken	8.3.61
Wt. Dry Mix	1400 gm.	Results	
Wt. Water	252 gm.	Aver. Dry Unit Wt. - pcf	100.4
Moulding Moisture Content		Aver. Unconf. Load - lbs.	1050
Container No.	J.191	Aver. Unconf. Press. - psi	334
Wt. Wet Soil + Tare	143.04 gm.	Aver. Soaked Moist. - %	19.8
Wt. Dry Soil + Tare	126.20 gm.	Vol. of Lime - cf	.206
Wt. Moisture	16.84 gm.	Vol. of Pozzolan - cf	.071
Wt. Tare	30.42 gm.	Vol. of Soil - cf	.351
Wt. Dry Soil	95.78 gm.	Vol. of Water - cf	.284
Moisture Content	17.6 %	Vol. of Solids - cf	.628

Sample No.	11	12	13	14	15	16
Height Dial - .0001	.465	.489	.492	.466	.488	.505
Sample Height - inch	1.965	1.989	1.992	1.966	1.988	2.005
Wt. Wet Sample - gm.	191.09	193.77	194.49	192.86	193.68	194.73
Dry Unit Wt. - pcf	100.1	100.2	100.5	101.0	100.3	100.0
Proving Dial - 0.0001	128	132	133	142	126	137
Unconf. Load - lbs.	1000	1040	1050	1120	990	1080
Tare No.	A.20	V.64.81	V.63	A.13	A.25	V.49
Wt. Wet Soil + Tare	109.97	114.32	121.42	114.70	108.34	120.95
Wt. Dry Soil + Tare	102.62	106.32	112.48	106.77	100.46	111.43
Wt. of Moisture	7.35	8.00	8.94	7.93	7.88	9.55
Wt. of Tare	66.37	66.41	66.72	66.22	60.48	62.90
Wt. Dry Soil	36.25	39.91	45.76	40.55	39.98	48.53
Soaked Moist. Cont. %	20.2	20.0	19.5	19.5	19.7	19.6
Soaked Dial Height	.466	.487	.496	.472	.490	.500

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	55R
Optimum Moisture Content	16.8 %	Lime-Pozzolan Ratio	9:1
Wt. Lime [27 %]	378 gm.	Percent Additive	30
Wt. Pozzolan [3 %]	42 gm.	Date Constructed	1.2.61
Wt. Soil	980 gm.	Date Broken	2.3.61
Wt. Dry Mix	1400 gm.	**Results**	
Wt. Water	235 gm.	Aver. Dry Unit Wt. - pcf	101.7
Moulding Moisture Content		Aver. Unconf. Load - lbs.	820
Container No.	J.148	Aver. Unconf. Press. - psi	261
Wt. Wet Soil + Tare	144.72 gm.	Aver. Soaked Moist. - %	18.5
Wt. Dry Soil + Tare	129.02 gm.	Vol. of Lime - cf	.217
Wt. Moisture	15.70 gm.	Vol. of Pozzolan - cf	.018
Wt. Tare	29.92 gm.	Vol. of Soil - cf	.398
Wt. Dry Soil	99.10 gm.	Vol. of Water - cf	.258
Moisture Content	15.8 %	Vol. of Solids - cf	.633

Sample No.	11	12	13	14	15	16
Height Dial - .0001	.488	.484	.490	.497	.479	.490
Sample Height - inch	1.988	1.984	1.990	1.997	1.979	1.990
Wt. Wet Sample - gm.	193.35	193.65	193.36	193.68	193.08	194.08
Dry Unit Wt. - pcf	101.7	102.0	101.5	101.3	102.0	101.9
Proving Dial - 0.0001	100	100	Sample	102	105	120
Unconf. Load - lbs.	780	780	Broken	800	820	940
			During			
Tare No.	V.31.15	V.79	Curing	V.59	V.68	V.52
Wt. Wet Soil + Tare	132.09	118.83		123.99	123.70	130.66
Wt. Dry Soil + Tare	120.47	109.69		114.73	114.80	121.29
Wt. of Moisture	11.62	9.14		9.26	8.90	9.37
Wt. of Tare	61.32	59.72		64.04	65.25	70.55
Wt. Dry Soil	59.15	49.97		50.69	49.55	50.74
Soaked Moist. Cont. %	19.7	18.3		18.1	18.0	18.5
Soaked Dial Height	.494	.481		.481	.478	.493

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	55 S
Optimum Moisture Content	15.8 %	Lime-Pozzolan Ratio	20:3
Wt. Lime [20 %]	280 gm.	Percent Additive	23
Wt. Pozzolan [3 %]	42 gm.	Date Constructed	1·2·61
Wt. Soil	1078 gm.	Date Broken	2·3·61
Wt. Dry Mix	1400 gm.	**Results**	
Wt. Water	221 gm.	Aver. Dry Unit Wt. - pcf	104.5
Moulding Moisture Content		Aver. Unconf. Load - lbs.	780
Container No.	J.149	Aver. Unconf. Press. - psi	248
Wt. Wet Soil + Tare	143.52 gm.	Aver. Soaked Moist. - %	17.6
Wt. Dry Soil + Tare	128.51 gm.	Vol. of Lime - cf	.149
Wt. Moisture	15.01 gm.	Vol. of Pozzolan - cf	.018
Wt. Tare	30.40 gm.	Vol. of Soil - cf	.471
Wt. Dry Soil	98.11 gm.	Vol. of Water - cf	.256
Moisture Content	15.3 %	Vol. of Solids - cf	.638

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.497	.511	.490	.516	.507	.506
Sample Height - inch	1.997	2.011	1.990	2.016	2.007	2.006
Wt. Wet Sample - gm.	199.44	198.82	199.34	199.58	199.25	200.12
Dry Unit Wt. - pcf	104.8	104.6	105.0	103.8	104.1	104.6
Proving Dial - 0.0001	103	95	105	99	95	102
Unconf. Load - lbs.	810	740	820	770	740	800
Tare No.	V.74	V.76	V.44	V.66	V.65	V.82
Wt. Wet Soil + Tare	129.67	124.78	112.59	128.82	119.92	124.75
Wt. Dry Soil + Tare	120.24	115.82	104.53	119.36	111.33	114.91
Wt. of Moisture	9.43	8.96	8.06	9.46	8.59	9.84
Wt. of Tare	66.54	61.50	58.41	66.30	64.68	60.05
Wt. Dry Soil	53.70	54.32	46.12	53.06	46.65	54.86
Soaked Moist. Cont. %	17.5	16.5	17.5	17.8	18.4	17.9
Soaked Dial Height	.494	.510	.486	.510	.504	.504

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	55T
Optimum Moisture Content	14.0 %	Lime-Pozzolan Ratio	10:3
Wt. Lime [10 %]	140 gm.	Percent Additive	13
Wt. Pozzolan [3 %]	42 gm.	Date Constructed	7.2.61
Wt. Soil	1218 gm.	Date Broken	8.3.61
Wt. Dry Mix	1400 gm.	Results	
Wt. Water	196 gm.	Aver. Dry Unit Wt. - pcf	110.1
Moulding Moisture Content		Aver. Unconf. Load - lbs.	690
Container No.	J.192	Aver. Unconf. Press. - psi	219
Wt. Wet Soil + Tare	145.83 gm.	Aver. Soaked Moist. - %	16.0
Wt. Dry Soil + Tare	131.13 gm.	Vol. of Lime - cf	.078
Wt. Moisture	14.70 gm.	Vol. of Pozzolan - cf	.019
Wt. Tare	30.90 gm.	Vol. of Soil - cf	.460
Wt. Dry Soil	100.23 gm.	Vol. of Water - cf	.258
Moisture Content	14.6 %	Vol. of Solids - cf	.557

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.463	.491	.503	.494	.505	.513
Sample Height - inch	1.963	1.991	2.003	1.994	2.005	2.013
Wt. Wet Sample - gm.	205.48	208.55	208.89	208.06	208.56	208.85
Dry Unit Wt. - pcf	110.4	110.5	110.0	110.1	109.8	109.7
Proving Dial - 0.0001	93	97	92	83	82	82
Unconf. Load - lbs.	730	760	720	650	640	640
Tare No.	A.17	V.74	V.78	A.18	V.18	A.14
Wt. Wet Soil + Tare	125.71	122.52	151.50	129.12	111.73	114.28
Wt. Dry Soil + Tare	118.08	114.88	141.97	120.53	104.62	107.09
Wt. of Moisture	7.63	7.64	9.53	8.59	7.11	7.19
Wt. of Tare	70.19	66.54	82.61	66.42	60.32	62.75
Wt. Dry Soil	47.89	48.34	59.36	54.11	44.30	44.34
Soaked Moist. Cont. %	16.0	15.8	16.1	15.9	16.1	16.2
Soaked Dial Height	.460	.486	.500	.492	.497	.508

LIME POZZOLAN SOIL STABILIZATION

OPTIMUM MOISTURE CONTENT	12.8 %	SERIES NO.	55·U
WT. LIME [5 %]	70 GM.	LIME-POZZOLAN RATIO	5:0
WT. POZZOLAN [0 %]	0 GM.	PERCENT ADDITIVE	5
WT. SOIL	1330 GM.	DATE CONSTRUCTED	3·2·61
WT. DRY MIX	1400 GM.	DATE BROKEN	4·3·61
WT. WATER	179 GM.	RESULTS	
MOULDING MOISTURE CONTENT		AVER. DRY UNIT WT. - PCF	113·6
		AVER. UNCONF. LOAD - LBS.	560
CONTAINER NO.	J·165	AVER. UNCONF. PRESS. - PSI	178
WT. WET SOIL + TARE	142·37 GM.	AVER. SOAKED MOIST. - %	15·0
WT. DRY SOIL + TARE	129·60 GM.	VOL. OF LIME - CF	.024
WT. MOISTURE	12·77 GM.	VOL. OF POZZOLAN - CF	—
WT. TARE	30·92 GM.	VOL. OF SOIL - CF	.644
WT. DRY SOIL	98·68 GM.	VOL. OF WATER - CF	.234
MOISTURE CONTENT	12·9 %	VOL. OF SOLIDS - CF	.668

SAMPLE NO:	1	2	3	4	5	6
HEIGHT DIAL - .0001	506	495	503	502	501	495
SAMPLE HEIGHT - INCH	2006	1.995	2.003	2.002	2.001	1.995
WT. WET SAMPLE - GM.	212·57	212.30	212·53	211·80	211·91	211·92
DRY UNIT WT. - PCF	113·6	114·1	113·7	113·3	113·3	113·8
PROVING DIAL - 0.0001	81	71	76	66	70	70
UNCONF. LOAD - LBS.	630	550	590	510	540	540
TARE NO.	V·82	A·3	V·29	V·49	V·85	V·41
WT. WET SOIL + TARE	130·08	122·52	129·19	129·93	154·10	111·71
WT. DRY SOIL + TARE	121·05	114·28	121·00	121·10	144·48	104·50
WT. OF MOISTURE	9·03	8·24	8·19	8·83	9·72	7·21
WT. OF TARE	60·05	58·85	66·29	62·90	80·28	56·10
WT. DRY SOIL	61·00	55·43	54·71	58·20	64·20	48·40
SOAKED MOIST. CONT. %	14·8	14·9	15·0	15·2	15·1	14·9
SOAKED DIAL HEIGHT	.500	.491	.498	.498	.498	.488

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	55V
Optimum Moisture Content	13.8 %	Lime-Pozzolan Ratio	10:0
Wt. Lime [10 %]	140 gm.	Percent Additive	10
Wt. Pozzolan [nil %]	nil gm.	Date Constructed	3.2.61
Wt. Soil	1260 gm.	Date Broken	4.3.61
Wt. Dry Mix	1400 gm.	**Results**	
Wt. Water	193 gm.	Aver. Dry Unit Wt. - pcf	110.7
Moulding Moisture Content		Aver. Unconf. Load - lbs.	580
Container No.	J.164	Aver. Unconf. Press. - psi	184
Wt. Wet Soil + Tare	122.89 gm.	Aver. Soaked Moist. - %	15.8
Wt. Dry Soil + Tare	110.36 gm.	Vol. of Lime - cf	.079
Wt. Moisture	12.53 gm.	Vol. of Pozzolan - cf	—
Wt. Tare	22.45 gm.	Vol. of Soil - cf	.582
Wt. Dry Soil	87.91 gm.	Vol. of Water - cf	.253
Moisture Content	14.3 %	Vol. of Solids - cf	.661

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.497	.507	.476	.502	.502	.505
Sample Height - inch	1.997	2.007	1.976	2.002	2.002	2.005
Wt. Wet Sample - gm.	209.21	210.21	208.21	209.11	209.61	209.83
Dry Unit Wt. - pcf	110.9	111.0	111.7	110.2	110.6	110.7
Proving Dial - 0.0001	79	83	71	71	73	.74
Unconf. Load - lbs.	610	650	550	550	570	570
Tare No.	V.74	V.57.10	A.24	V.81.64	V.79	V.28
Wt. Wet Soil + Tare	125.83	130.79	130.34	129.02	128.85	151.77
Wt. Dry Soil + Tare	117.65	122.65	120.42	120.60	119.60	142.35
Wt. of Moisture	9.18	8.14	9.92	8.42	9.25	9.42
Wt. of Tare	66.54	71.51	59.97	66.41	59.72	82.58
Wt. Dry Soil	51.11	51.14	60.45	54.19	59.88	59.77
Soaked Moist. Cont. %	16.0	15.9	16.4	15.5	15.5	15.8
Soaked Dial Height	.493	.505	.475	.496	.504	.503

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LIME POZZOLAN SOIL STABILIZATION

		Series No.	55W
Optimum Moisture Content	15.1 %	Lime-Pozzolan Ratio	20.0
Wt. Lime [20 %]	280 gm.	Percent Additive	20
Wt. Pozzolan [nil %]	nil gm.	Date Constructed	3.2.61
Wt. Soil	1120 gm.	Date Broken	4.3.61
Wt. Dry Mix	1400 gm.	Results	
Wt. Water	212 gm.	Aver. Dry Unit Wt. - pcf	105.6
Moulding Moisture Content		Aver. Unconf. Load - lbs.	680
Container No.	J.163	Aver. Unconf. Press. - psi	216
Wt. Wet Soil + Tare	151.01 gm.	Aver. Soaked Moist. - %	17.6
Wt. Dry Soil + Tare	135.18 gm.	Vol. of Lime - cf	.150
Wt. Moisture	16.83 gm.	Vol. of Pozzolan - cf	—
Wt. Tare	29.37 gm.	Vol. of Soil - cf	.494
Wt. Dry Soil	105.81 gm.	Vol. of Water - cf	.271
Moisture Content	15.9 %	Vol. of Solids - cf	.644

Sample No:	1	2	3	4	5	6
Height Dial - .0001	.499	498	501	.496	.510	.498
Sample Height - inch	1.999	1.998	2.001	1.996	2.010	1.998
Wt. Wet Sample - gm.	202.40	202.22	203.02	201.47	203.08	202.51
Dry Unit Wt. - pcf	105.8	105.7	105.8	105.3	105.4	105.8
Proving Dial - 0.0001	83	95	97	75	90	83
Unconf. Load - lbs.	650	740	760	580	700	650
Tare No.	144	145	146	H.16	H.13	H.18
Wt. Wet Soil + Tare	174.11	169.28	162.95	109.60	120.84	118.85
Wt. Dry Soil + Tare	160.56	156.84	151.16	97.02	108.72	107.32
Wt. of Moisture	13.55	12.44	11.79	12.58	12.12	11.53
Wt. of Tare	83.17	86.09	83.70	26.49	40.20	41.05
Wt. Dry Soil	77.39	70.75	67.46	70.53	68.52	66.27
Soaked Moist. Cont. %	17.5	17.6	17.5	17.8	17.7	17.4
Soaked Dial Height	.492	.492	498	492	503	492

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LIME POZZOLAN SOIL STABILIZATION

Optimum Moisture Content	11.0 %	Series No.	55X
Wt. Lime [nil %]	nil gm.	Lime-Pozzolan Ratio	—
Wt. Pozzolan [nil %]	nil gm.	Percent Additive	nil
Wt. Soil	1500 gm.	Date Constructed	2·2·61
Wt. Dry Mix	1500 gm.	Date Broken	3·3·61
Wt. Water	165 gm.	**Results**	
Moulding Moisture Content		Aver. Dry Unit Wt. - pcf	122.1
		Aver. Unconf. Load - lbs. *	890
Container No.	J.149	Aver. Unconf. Press. - psi*	283
Wt. Wet Soil + Tare	89.14 gm.	Aver. Soaked Moist. - %	11.7
Wt. Dry Soil + Tare	82.30 gm.	Vol. of Lime - cf	—
Wt. Moisture	6.84 gm.	Vol. of Pozzolan - cf	—
Wt. Tare	22.48 gm.	Vol. of Soil - cf	.713
Wt. Dry Soil	59.82 gm.	Vol. of Water - cf	.223
Moisture Content	11.4 %	Vol. of Solids - cf	.713

Sample No.	1	2	3	4	5	6
Height Dial - .0001	.483	.485	.485	.492	.483	.483
Sample Height - inch	1.983	1.985	1.985	1.992	1.983	1.983
Wt. Wet Sample - gm.	222.90	223.50	223.69	223.42	223.39	223.73
Dry Unit Wt. - pcf	122.0	122.2	122.3	121.8	122.3	122.3
Proving Dial - 0.0001	111	112	113	12	Failed	118
Unconf. Load - lbs.	870	880	890	90	by	930
					disinteg-	
Tare No.	H.15	H.16	H.17	H.18	ration of	H.19
Wt. Wet Soil + Tare	94.40	83.35	87.06	120.83	sample	122.36
Wt. Dry Soil + Tare	88.75	77.32	82.08	109.18	soaked	114.97
Wt. of Moisture	5.65	6.03	4.98	11.65	in	7.39
Wt. of Tare	40.82	26.49	39.79	41.05	water.	51.97
Wt. Dry Soil	47.93	50.83	43.29	68.13		63.00
Soaked Moist. Cont. %	11.8	11.9	11.5	17.2		11.7
Soaked Dial Height	.475	.481	.479	.535		.481

APPENDIX G

PHYSICAL TEST DATA ON LIME POZZOLAN AND SOIL

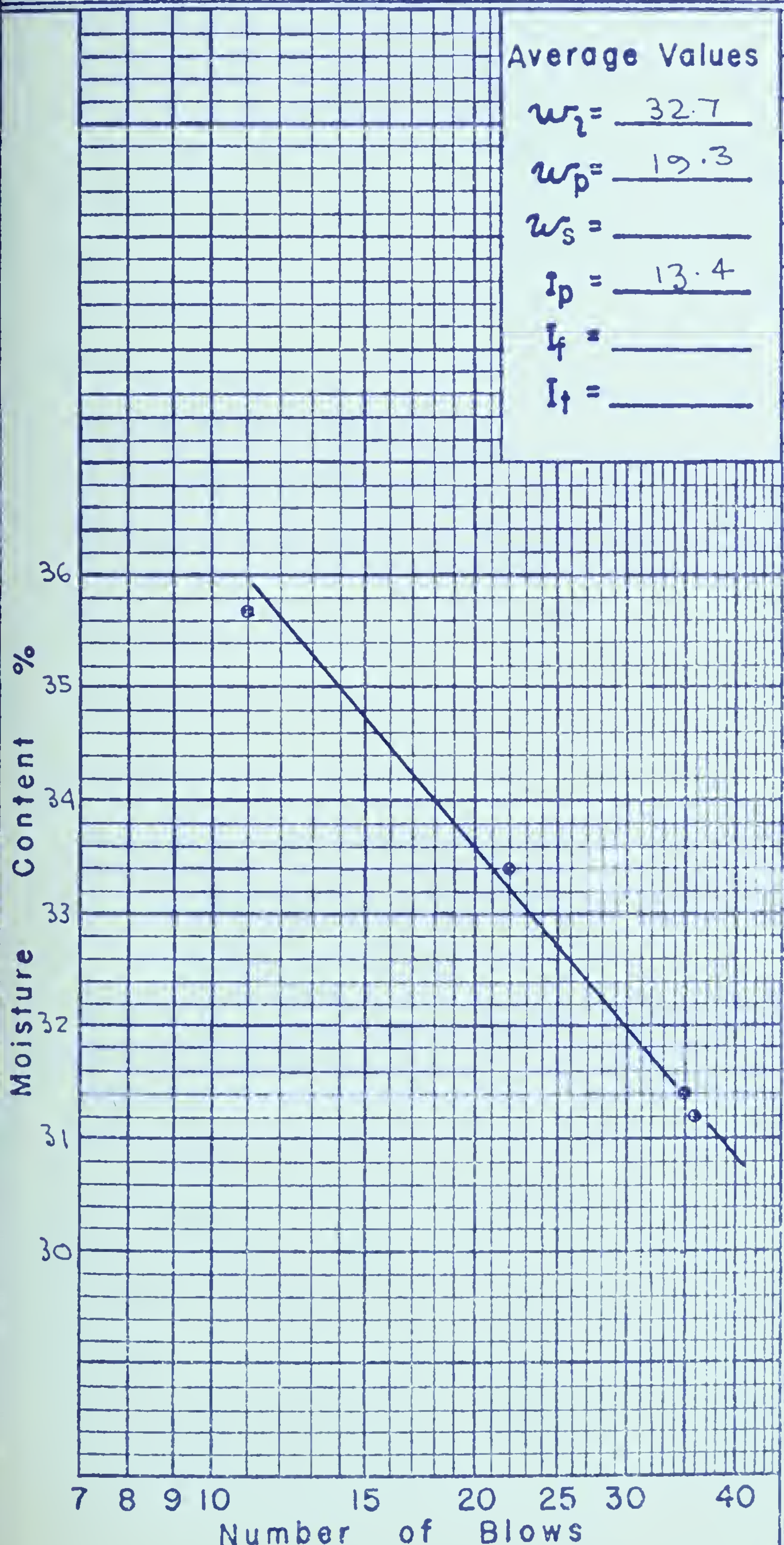
UNIVERSITY of ALBERTA
DEP'T. of CIVIL ENGINEERING
SOIL MECHANICS LABORATORY

ATTERBERG LIMITS

PROJECT. LIME POZZOLAN STABILIZATION		
SITE		
SAMPLE	Soil	16·C·1
LOCATION		
HOLE		DEPTH
TECHNICIAN	DK	DATE 14·12·60

Liquid Limit

Trial No.	1	2	3	4		
No. of Blows	35	36	22	11		
Container No.	V·63	V·65	V·70	V·69		
Wt. Sample Wet + Tare	87·753	90·175	85·434	93·993		
Wt. Sample Dry + Tare	82·760	84·133	79·011	86·353		
Wt. Water	4·993	6·042	6·423	7·639		
Tare Container	66·851	64·786	60·063	64·935		
Wt. of Dry Soil	15·909	19·347	18·948	21·418		
Moisture Content w%	31·4	31·2	33·4	35·7		



Average Values

w_l = 32·7

w_p = 19·3

w_s =

I_p = 13·4

I_f =

I_t =

Plastic Limit

Trial No.	1	2	3
Container No.	JH·2	JH·3	J.H.4
Wt. Sample Wet+Tare	44·890	44·762	45·195
Wt. Sample Dry + Tare	43·524	43·400	43·818
Wt. Water	1·366	1·362	1·377
Tare Container	36·395	36·185	36·696
Wt. of Dry Soil	7·129	7·215	7·122
Moisture Content %	19·3	18·9	19·8

Shrinkage Limit

Trial No.			
Container No.			
Wt. Sample Wet + Tare			
Wt. Sample Dry + Tare			
Wt. Water			
Tare Container			
Wt. of Dry Soil W_o			
Moisture Content w%			
Vol. Container V			
Vol. Dry Soil Pat V_o			
Shrinkage Vol. $V-V_o$			
Shrinkage Limit w_s			

$$w_s = w - \left(\frac{V-V_o}{W_o} \times 100\right)$$

Description of Sample:

Remarks:

UNIVERSITY of ALBERTA
DEP'T. of CIVIL ENGINEERING
SOIL MECHANICS LABORATORY

MOISTURE CONTENT

PROJECT	LIME · POZZOLAN · STABILIZATION
SITE	DETERMINATION OF
SAMPLE	LIME FIXATION CAPACITY
LOCATION	
HOLE	DEPTH
TECHNICIAN J. HVOZDANSKI	DATE 22.12.60

Hole No.		8% Lime			4% Lime	
Depth	Average P.L = 27.7			Average P.L. = 27.0		
Sample No.	V.4	V.4	V.4	V.3	V.3	V.3
Container No.	JH.8	JH.7	JH.15	JH.10	JH.11	JH.18
Wt. Sample Wet + Tare	40.522	42.021	43.686	45.115	42.647	60.548
Wt. Sample Dry + Tare	39.503	40.502	42.289	43.215	41.223	59.282
Wt. Water	1.019	1.519	1.397	1.900	1.424	1.266
Tare Container	35.907	35.063	37.085	36.019	35.852	54.766
Wt. of Dry Soil	3.596	5.439	5.204	7.196	5.371	4.516
Moisture Content w %	28.3	27.9	26.9	26.4	26.5	28.0
Hole No		3% Lime			2% Lime	
Depth	Average P.L. = 26.5			Average P.L. = 25.6		
Sample No.	V.26	V.26	V.26	V.29	V.29	V.29
Container No.	JH.16	JH 9	JH.13	J.H.12	JH 14	JH.1
Wt. Sample Wet + Tare	65.389	66.924	66.120	59.752	42.707	57.040
Wt. Sample Dry + Tare	62.792	64.190	63.602	58.707	41.432	56.282
Wt. Water	2.597	2.734	2.518	1.045	1.275	0.758
Tare Container	52.978	54.080	53.911	54.657	36.437	53.294
Wt. of Dry Soil	9.814	10.110	9.691	4.050	4.995	2.988
Moisture Content w %	26.5	27.0	26.0	25.8	25.5	25.4
Hole No.		1% Lime			Natural Soil	
Depth	Average P.L = 23.2			Average P.L = 19.3		
Sample No.	V.25	V.25	V.25			
Container No.	JH.17	JH 6	JH 5	J.H.2	J.H 3	J.H 4
Wt. Sample Wet + Tare	44.000	48.250	46.965	44.890	44.762	45.195
Wt. Sample Dry + Tare	42.343	46.130	44.854	43.524	43.400	43.818
Wt. Water	1.657	2.120	2.111	1.366	1.362	1.377
Tare Container	35.275	36.948	35.764	36.395	36.185	36.696
Wt. of Dry Soil	7.068	9.182	9.090	7.129	7.215	7.122
Moisture Content w %	23.4	23.1	23.2	19.3	18.9	19.8

Remarks: All samples containing lime were cured for 24 hours after wet mixing with lime added.
Natural soil also cured for 24 hrs.

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SPECIFIC GRAVITY

PROJECT · LIME · POZZOLAN · STABILIZATION
SITE
SAMPLE Soil 16 · C · 1
LOCATION
HOLE DEPTH
TECHNICIAN · J. HVOZDANSKI DATE 28 · 12 · 61

Sample No.			
Flask No.	B·1	B 2	B·3
Method of Air Removal	Air Pump		
W_{b+w+s}	760·84	751 05	749·97
Temperature T	21·8	21 4	21·4
W_{b+w}	702·08	696 47	691·82
Evaporating Dish No.			
Wt. Sample Dry + Dish	296·72	284 52	285·41
Tare Dish	204·21	198 84	193·59
W_s	92·51	85 68	91·82
G_s	2·74	2 74	2·73

W_{b+w+s} = Weight of flask + water + sample at T°.
W_{b+w} = Weight of flask + water at T° (flask calibration curve).
W_s = Weight of dry soil
G_s = Specific gravity of soil particles $= \dfrac{W_s}{W_s + W_{b+w} - W_{b+w+s}}$

Determination of W_s from wet soil sample:

Sample No.			Sample No.		
Container No.			Container No.		
Wt. Sample Wet + Tare			Wt. Test Sample Wet + Tare		
Wt. Sample Dry + Tare			Tare Container		
Wt. Water			Wt. Test Sample Wet		
Tare Container			W_s		
Wt· of Dry Soil					
Moisture Content w %					

Description of Sample: Light tan silty clay when dry.

Remarks:

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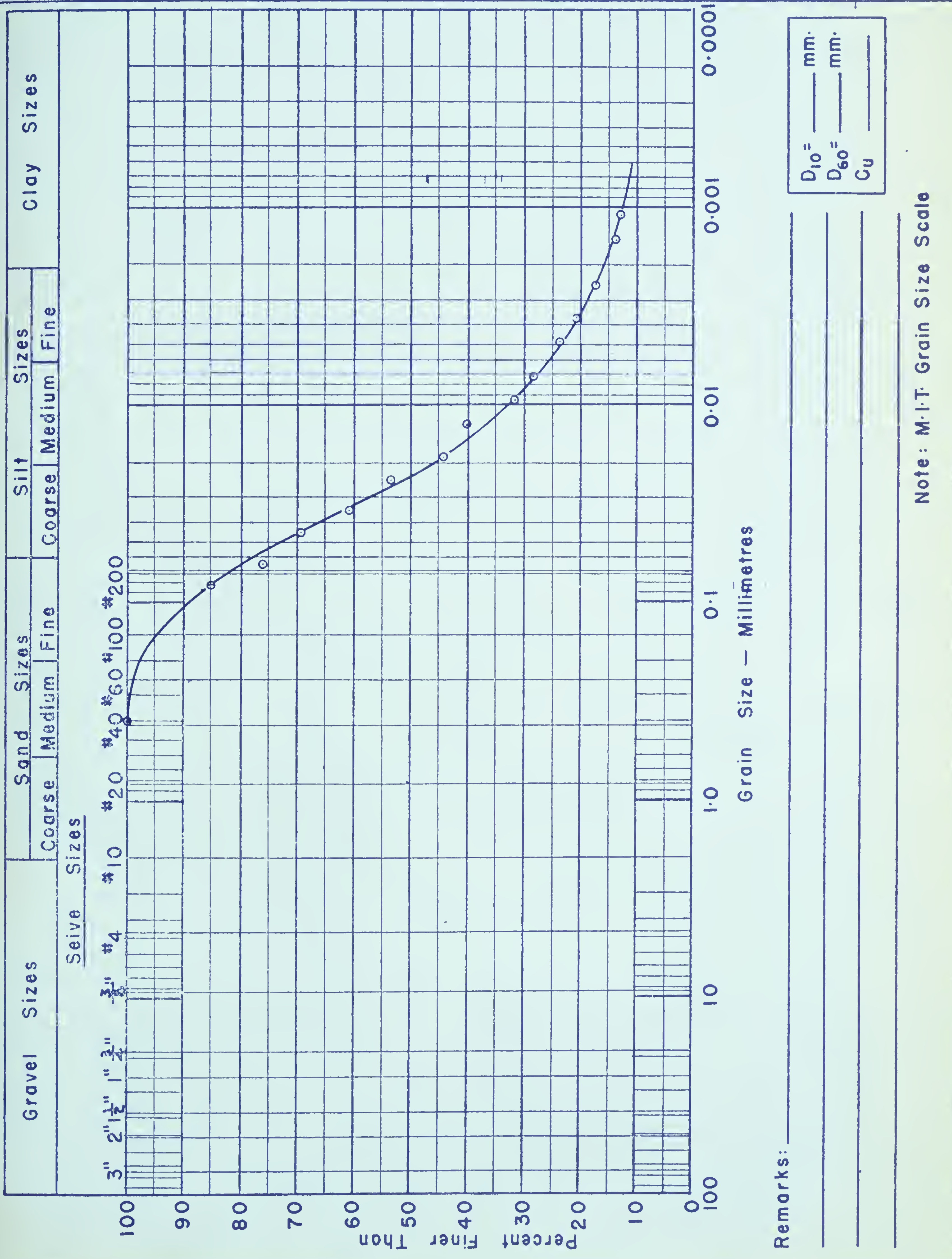
GRAIN SIZE CURVE

PROJECT	LIME · POZZOLAN · STABILIZATION
SITE	
SAMPLE	SOIL 16 · C · 1
LOCATION	
HOLE	DEPTH
TECHNICIAN J. HVOZDANSKI	DATE 17·2·61



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HYDROMETER TEST

PROJECT· LIME·POZZOLAN·STABILIZATION
SITE
SAMPLE · Soil 16·C·1
LOCATION
HOLE DEPTH
TECHNICIAN· J·HVOZDANSKI DATE 17·2·61

Date	Temp·	Time	Elapsed Time	R_h'	$R_h = R_h' + c_m$	D m.m.	$R_h + m_t - c_d$	W %	W % Basis Orig. Sample	Remarks
17·2·61		13:19:00	0							
		:15	15s	6·0	6·5	0·11	7·1		97·0	
		:30	30s	5·0	5·5	·076	6·1		83·3	
		13:20:00	60s	4·8	5·3	·055	5·9		80·6	
		13:21	2m	4·2	4·7	·039	5·3		72·4	
		13:23	4m	2·9	3·4	·028	4·0		54·7	
		13·27	8m	2·2	2·7	·020	3·3		45·1	
		13·34	15m	1·0	1·5	·015	2·1		28·7	
		13·49	30m	0·8	1·3	·011	1·9		26·0	
		14·19	60m	0·1	0·6	·0075	1·2		16·4	
		15·30	2hr 11m	0·0	0·5	·0050	1·1		15·0	
		17·40	4hr·21m	0·0	0·5	·0035	1·1		15·0	

Hydrometer No.s 9853 R and ______ Graduate No. J·H·3

$W\% = \frac{100}{W_s} \cdot \frac{S_s}{S_s - 1}(R_h + m_t - c_d) =$ 13·7 $(R_h + m_t - c_d)$

Meniscus correction = c_m = +0·5 and ______ respectively

Dispersing agent used nil Amount ______

Correction for change in density of liquid due to addition of dispersing agent = c_d

c_d = nil and ______ respectively

Specific Gravity of Solids = G_s 2·74

Description of Sample Reddish-brown ground calcined shale.

Method of Preparation ______

Remarks ______

Initial Moisture Content

Container No. ______
Wt. Sample Wet + Tare ______
Wt. Sample Dry + Tare ______
Wt. Water ______
Tare Container ______
Wt. of Dry Soil ______
Initial Moisture w % ______

Dry Weight of Sample

Container No. ______
Wt. Sample (Wet/Dry) + Tare ______
Tare ______
Wt. (Wet/Dry) Soil ______
Dry Weight from Initial
Moisture = $\frac{100 \times \text{Wt. Wet Soil}}{100 + \text{Init. Moist.}\%}$ = 11·50 gm.

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HYDROMETER TEST

PROJECT · LIME · POZZOLAN STABILIZATION
SITE
SAMPLE ·16·C·1
LOCATION
HOLE DEPTH
TECHNICIAN J. HVOZDANSKI DATE 17·2·61

Date	Temp· °C	Time	Elapsed Time	R_h'	$R_h = R_h' + c_m$	D m.m.	$R_h + m_t - c_d$	W %	W % Basis Orig. Sample	Remarks
17·2·61		12:00:00	0							
		:15	15s	26·0	26·6	·087	26·9		84·7	
		:30	30s	23·2	23·8	·063	24·1		75·8	
		12:01:00	60s	21·0	21·6	·046	21·9		69·0	
		12:02	2m	18·5	19·1	·035	19·4		61·1	
		12:04	4m	16·0	16·6	·024	16·9		53·2	
	23·3	12:08	8m	13·2	13·8	·018	14·1		44·3	
	23·2	12:15	15m	11·9	12·5	·013	12·8		40·3	
	23·0	12:30	30m	9·3	9·8	·0096	10·1		31·6	
	22·7	13:00	60m	8·0	8·6	·0070	8·9		28·0	
	22·0	14:00	2hr.	7·0	7·6	·0048	7·6		23·9	
	21·8	16:00	4hr	6·0	6·6	·0036	6·6		20·8	
	21·7	20:00	8hr	5·1	5·7	·0025	5·6		17·6	
18·2·61	21·0	08:30	20hr·30m	4·6	4·6	·0016	4·4		13·8	
19·2·61	21·0	11:30	47hr·30m	3·8	4·4	·0011	4·2		13·2	

Hydrometer No.s 9853 R and ______ Graduate No. J.H.1

$W\% = \frac{100}{W_s} \cdot \frac{S_s}{S_s - 1} (R_h + m_t - c_d) =$ 3.15 $(R_h + m_t - c_d)$

Meniscus correction $= c_m =$ +0·6 and ______ respectively

Dispersing agent used 6 % Calgon Amount 10 c.c.

Correction for change in density of liquid due to addition of dispersing agent $= c_d$

$c_d =$ -0·4 and ______ respectively

Specific Gravity of Solids $= G_s$ 2·74

Description of Sample Light tan when dry silty clay

Method of Preparation Disassociated in Los Angeles Abrasion Machine

Remarks ______

Initial Moisture Content

Container No. ______
Wt. Sample Wet + Tare ______
Wt. Sample Dry + Tare ______
Wt. Water ______
Tare Container ______
Wt. of Dry Soil ______
Initial Moisture w % ______

Dry Weight of Sample

Container No. ______
Wt. Sample (Wet/Dry) + Tare ______
Tare ______
Wt. (Wet/Dry) Soil ______
Dry Weight from Initial

Moisture $= \frac{100 \times \text{Wt. Wet Soil}}{100 + \text{Init. Moist.}\%} =$ 50·00 gm.

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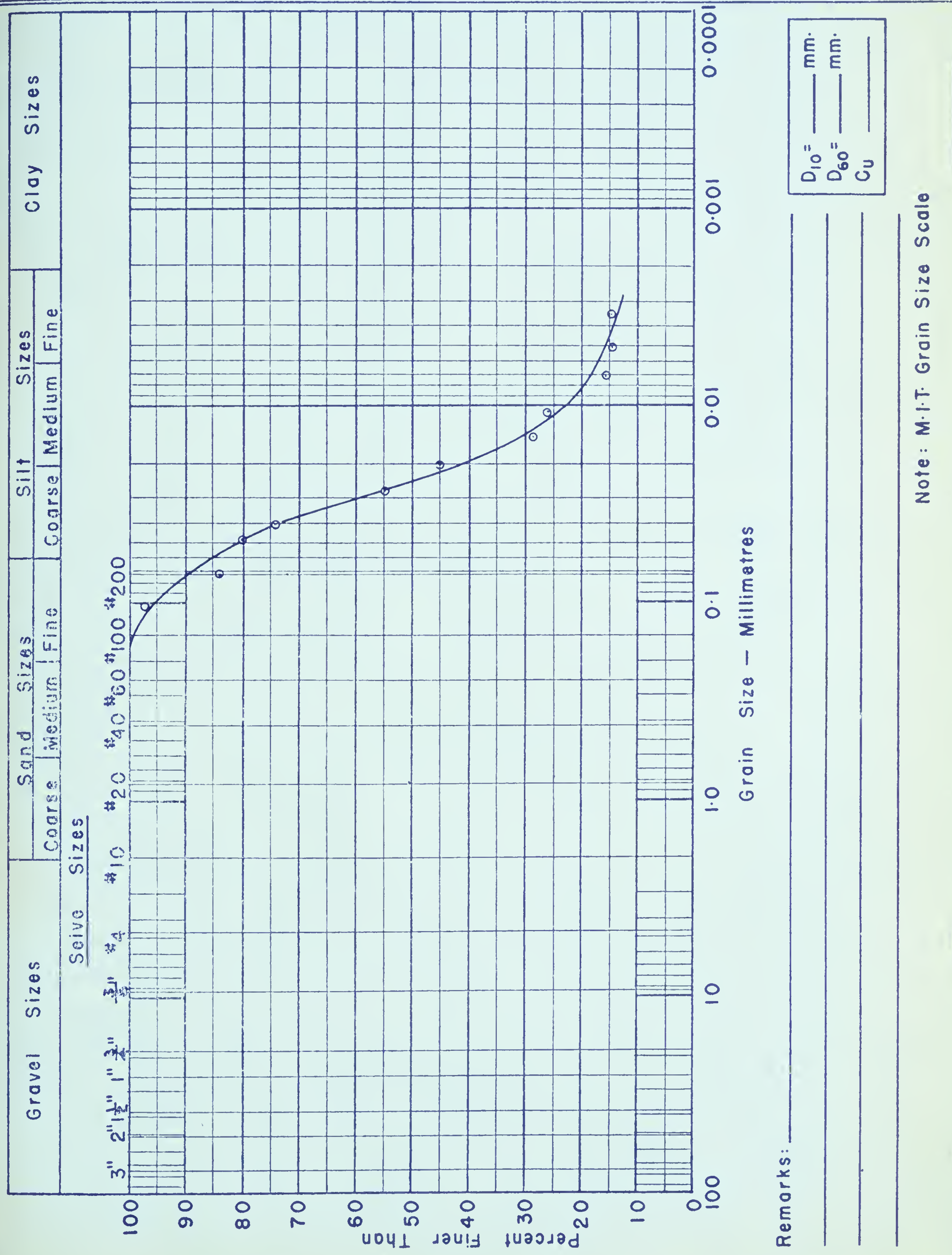
GRAIN SIZE CURVE

PROJECT · LIME · POZZOLAN · STABILIZATION	
SITE	
SAMPLE DIAMOND · CITY · SHALE · (POZZOLAN)	
LOCATION LETHBRIDGE	
HOLE	DEPTH
TECHNICIAN · J · HVOZDANSKI	DATE 17 · 2 · 61



UNIVERSITY of ALBERTA DEP'T. of CIVIL ENGINEERING SOIL MECHANICS LABORATORY **SPECIFIC GRAVITY**	PROJECT LIME·POZZOLAN·STABILIZATION SITE SAMPLE HYDRATED LIME LOCATION HOLE DEPTH TECHNICIAN J. HVOZDANSKI DATE 17·2·61

Sample No.	1	
Flask No.	B·1	
Method of Air Removal	Vacuum Pump	
W_{b+w+s}	761.41	
Temperature T	23.7	
W_{b+w}	701.80	
Evaporating Dish No.		
Wt. Sample Dry + Dish	308.28	
Tare Dish	204.20	
W_s	104.08	
G_s	2.25	

W_{b+w+s} = Weight of flask + water + sample at T°.
W_{b+w} = Weight of flask + water at T° (flask calibration curve).
W_s = Weight of dry soil
G_s = Specific gravity of soil particles $= \dfrac{W_s}{W_s + W_{b+w} - W_{b+w+s}}$

Determination of W_s from wet soil sample:

Sample No.			Sample No.		
Container No.			Container No.		
Wt. Sample Wet + Tare			Wt. Test Sample Wet + Tare		
Wt. Sample Dry + Tare			Tare Container		
Wt. Water			Wt. Test Sample Wet		
Tare Container			W_s		
Wt. of Dry Soil					
Moisture Content w %					

Description of Sample: Purchased in 40 lb. paper sack from Builder's Supplies Ltd. and manufactured by Loder Lime.

Remarks: Physical analysis supplied by Loder Lime gives $G_L = 2.2$

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SPECIFIC GRAVITY

PROJECT ·LIME · POZZOLAN STABILIZATION	
SITE	
SAMPLE	16·C·1
LOCATION	
HOLE	DEPTH
TECHNICIAN· J·HVOZDANSKI	DATE 17·2·61

Sample No.	1	
Flask No.	B·2	
Method of Air Removal	Vacuum Pump	
W_{b+w+s}	759·67	
Temperature T °C	24·0	
W_{b+w}	696·14	
Evaporating Dish No.		
Wt. Sample Dry + Dish		
Tare Dish		
W_s	100·0	
G_s	2·74	

W_{b+w+s} = Weight of flask + water + sample at T°.
W_{b+w} = Weight of flask + water at T° (flask calibration curve).
W_s = Weight of dry soil
G_s = Specific gravity of soil particles $= \frac{W_s}{W_s + W_{b+w} - W_{b+w+s}}$

Determination of W_s from wet soil sample:

Sample No.			Sample No.		
Container No.			Container No.		
Wt. Sample Wet + Tare	191.32		Wt. Test Sample Wet + Tare	299.20	
Wt. Sample Dry + Tare	190·15		Tare Container	198·40	
Wt. Water	1·17		Wt. Test Sample Wet	100·80	
Tare Container	31·03		W_s	100·00	
Wt· of Dry Soil	159·12				
Moisture Content w %	0·74				

Description of Sample:

Remarks: